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SSME STRUCTURAL COMPUTER PROGRAM DEVELOPMENT

BOPACE USER MANUAL

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1.0 INTRODUCTION

BOPACE is the acronym for the <u>Boeing Plastic Analysis Capability</u> for <u>Engines</u>. BOPACE was developed by Boeing/Huntsville to meet the evident need for an advanced thermal-elastic-plastic-creep structural analyzer. Although BOPACE development has been strongly influenced by the requirements for structural analysis of engines, in particular the space shuttle main engine, its capabilities have been kept quite general and it is applicable to many types of nonlinear structures.

The philosophy for program development was based on the following requirements.

- 1) Analysis of very high temperature and large plastic-creep effects.
- Treatment of cyclic thermal and mechanical loads.
- 3) Improved material constitutive theory which closely follows actual behavior under variable temperature conditions.
- 4) A stable numerical solution approach which avoids cumulative errors.
- 5) Capability for handling up to 1000 degrees of freedom with moderate computation cost.

Although the finite-element method was first applied to plasticity in the early 1960's, and several good programs for nonlinear analysis have since been developed, numerous improvements were indicated in order to satisfy the above requirements. For example, some other available

programs assume linear plastic hardening, accumulate errors by failing to satisfy equilibrium at each step, or do not completely account for the effects of variable temperature on the elastic and plastic relations. The stated requirements have been effectively met by the current BOPACE program version. In addition, the research and development effort has led to an improved hardening theory for cyclic plasticity, a method for representing general cases of load reversal, and advanced techniques for improving the accuracy and controlling convergence of highly nonlinear solutions.

Two versions of the current BOPACE program are available. The first is a 300-DOF version developed for fast analysis of small size problems within moderate core-storage limitations. The second is the basic 1000-DOF version. In addition, a low-core modification of the 1000-DOF version has been accomplished through the use of overlays and dynamic storage of arrays. BOPACE is written in FORTRAN IV and has been extensively run on both the IBM 360 and UNIVAC 1108 computer systems. Documentation consists of three volumes: Theoretical Manual, User Manual (including example problems), and Programmer Manual.

The BOPACE development and programming effort has been performed at Boeing/Huntsville by Dr. R. G. Vos, with suggestions and review by W. H. Armstrong. A. H. Spring assisted with many analyses and program checkout. J. L. Ballinger of Boeing Computer Services modified and

programmed the Gauss wavefront solution method. Recognition is also due to N. L. Schlemmer, L. Salter and R. Hurford at the NASA Marshall Space FLight Center, and L. Johnston of Brown Engineering Co., for their suggestions and support of the program development.

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2.0 SUMMARY OF BOPACE INPUT DATA

A pictorial of the BOPACE input deck is shown in Figure 2.0-1. The input data consists of the following three general types:

Type C:

Data on the usual card file. These are data

which are needed for each start or restart.

Data on File I. These are basic structural Type I:

data for a given problem, such as material

properties and mesh data. They are the same

for all load increments and are needed only

when starting.

Data on File II. These are incremental thermal-Type II:

load and z-load data which are needed for each

start or restart.

The data included on each file are described below. Formats are consistent with FORTRAN IV conventions.

C-1. Start-restart code and data file numbers:

- "START" if new problem, or "RESTART" if restarting.
- b. If starting give unit number for file I.
- Unit number for file II.
- d. Unit number for output file (e.g. printer).

- e. If restarting give load increment number from the end of which a restart is to be made.
- f. If restarting give input restart-tape unit number.
- g. If data is to be saved for future restart give output restarttape unit number.

Format (A4,6X,6I5)

C-2. Problem I.D. title.
Format (20A4).

- C-3. Program control constants (any constant left blank is assigned a default value):
 - a. Code for system matrix decomposition and solution. This code controls only the method of iteration and convergence, and does not affect final computed results.

Code 1 = use only elastic matrix with no updating.

2 = update elastic matrix.

3 = update plastic matrix.

4 = update total Jacobian (elastic+plastic) matrix.

5 = update both elastic and total Jacobian matrices.

The default code is 5.

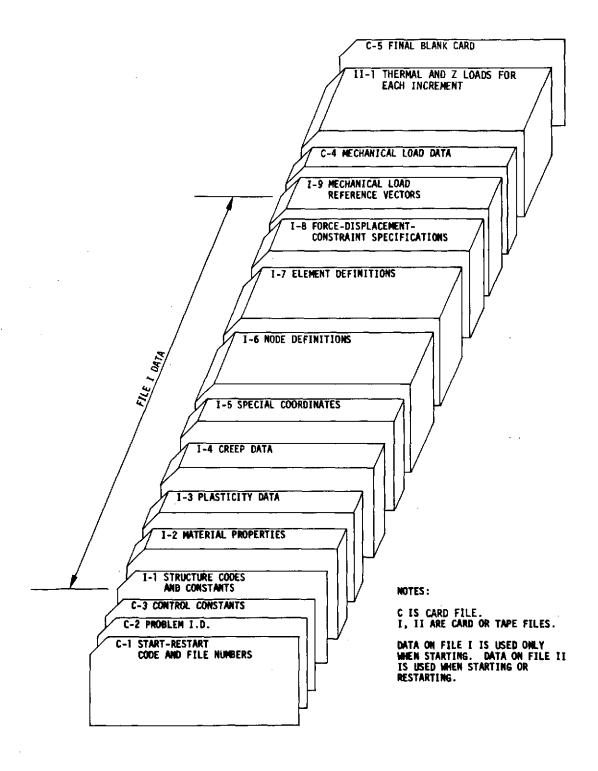


FIGURE 2.0-1: BOPACE INPUT DECK SETUP

- Maximum number of stiffness updates per load increment (in order to achieve convergence to within allowable error norm).
 Default = 1.
- c. Maximum number of residual-force iterations per stiffness update. Default = 10.
- d. Maximum number of initial iterations using elastic matrix(to account for possible unloading). Default = 2.
- e. Maximum allowable magnitude for elastic-plastic sum code YCODE1. Default = 2.
- f. Maximum number of cuts to be performed (giving new solution with a fraction of previously used displacement corrections) if error norm is not decreasing. Default = 0.
- g. Cutting fraction (displacement correction = previous correction times cutting fraction). Default = 0.5.
- h. Maximum allowable error norm. Default = 0.001.
 - i. Fraction from end of increment to evaluate stress vs. plasticstrain slope in forming plastic stiffness. Default = 0.1.

Format (615,3F10.0)

I-1. Plane-stress code (0) or plane-strain code (1), number of materials, default thickness, fabrication temperature.
Format (215,2F10.0)

- 2.0 (Continued)
- I-2. Material property data for each consecutive material.
 - a. Material numberFormat (I10)
 - b. Three consecutive temperature-dependent property curves (thermal strain, elastic modulus, Poisson's ratio). For each curve point give temperature and value, with points in order of increasing temperature. User has option of from 1 to 4 points per card.

Format (8F10.0)

Blank card after last point of each curve.

- I-3. Plasticity data for each consecutive material.
 - a. Material number, plasticity type, kinematic code.

Type 1 = strain hardening

2 = work hardening

Code 0 = kinematic hardening is function of one parameter

1 = kinematic hardening is function of two parameters

Format (3110)

b. Temperature-parameter-hardening data, in order of low to high temperatures. For each temperature:

Material number, temperature. Format (I10,F10.0)

Three consecutive hardening curves (cumulative hardening parameter vs. isotropic hardening, i.e. yield surface size; kinematic parameter vs. kinematic hardening shape; cumulative parameter vs. kinematic hardening factor). Bauschinger hardening is computed as kinematic hardening shape times hardening factor. If kinematic code = 0, curve of kinematic factors is not given and all factors are taken as 1.0. For each point give parameter and hardening value. User has option of from 1 to 4 points per card. First point on each curve must be yield point (parameter = 0.0).

Format (8F10.0)

Insert blank card after each input curve.

Blank card after all temperatures for a given material.

- I-4. Creep data for each consecutive material.
 - a. Material number, creep type.

Type 1 = age hardening

2 = strain hardening

3 = work hardening

Format (2110)

b. Reference creep curve. For each point, the time and creep strain, in order of increasing time. User has the option of from 1 to 4 points per card.

Format (8F10.0)

Blank card after last point of curve.

c. Table of creep factors, in order of low to high temperatures.
Creep is computed as factor (function of temperature and stress) times reference creep curve.

For each temperature:

Material number, temperature Format (I10,F10.0)

For each point given at this temperature, the stress and creep factor, in order of increasing stress. User has option of from 1 to 4 points per card.

Format (8F10.0)

Blank card after all points for a given temperature.

Blank card after all temperatures for a given material.

I-5. For each special Cartesian coordinate system: the identification
number (integer = 2) and counter-clockwise angle (degrees) from
basic system X-axis to special system x-axis.
Format (I10,F10.0)

Blank card after last coordinate system.

I-6. For each node: Node I.D. number, identification number of coordinate system to define location, X and Y (or R and θ), identification number of coordinate system to define displacements. (Coordinate identification number 0 implies the basic Cartesian system, 1 implies the basic cylindrical system). Order of nodes in data deck is internal order used to form system matrix. Format (215,2F10.0, I5)

Blank card after last node.

I-7. For each element: element I.D. number, material number, thickness, three node I.D. numbers (counter-clockwise order). If thickness is left blank, default value from I-l is used.

Format (215,F10.0,315).

Blank card after last element.

- I-8. For each degree of freedom with a specified force, displacement or constraint: give node I.D. number, component number (1 or 2), and code. The code to be given is:
 - 1. For specified force, the node I.D. number
 - For specified displacement, the negative of the node I.D. number.

For dependent constrained DOF, the node I.D. number of the independent DOF in constraint.

The default code is specified force. User has option of from one to four DOF per card.

Format (4(315,5X))

Blank card after last force-displacement-constraint DOF.

I-9. Mechanical load reference vectors

Number of vectors (for current program version must be 2)
Format (I10)

For each non-zero component of load vector: node I.D. number, component number (1 = X or R, 2 = Y or θ), value. User has option of from 1 to 4 values per card. Format (4(215,F10.0))

Blank card after last value of each vector.

C-4. Incremental mechanical load data.

Number of load increments Format (I10)

For each load increment: maximum iterations per stiffness update (if left blank, value from C-3 is used), the cumulative factors to be applied to load reference vectors (for current version of

program two factors must be given), creep time increment (if left blank, no creep calculations are made).

Format (I10,3F10.0)

- II-1. Incremental thermal and z-direction load data.
 - a. Increment I.D. titleFormat (20A4)
 - b. Element thermal loads. For each specified component of load:
 element I.D. number, temperature at end of increment. Nonspecified temperatures are taken to be the fabrication
 temperature for the first increment; for later increments they
 are taken to be the temperature of the preceding increment.
 User has option of from one to four values per card.
 Format (4(IIO,FIO.O))

Blank card after last specified value of thermal load for each load increment.

c. Element z-stress (for a plane-stress problem) or z-strain (for a plane-strain problem). Plane-stress or plane-strain condition is defined by code in data item I-1. For each specified element z-load: element I.D. number, stress or strain at the end of increment. Non-specified z-loads are taken to be zero for the first increment; for later increments they are taken to be the z-load of the preceding increment. User has option

of from one to four values per card.

Format (4(I10,F10.0))

Blank card after last specified value of z-load for each load increment.

C-5. Blank card after last problem.

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3.0 SUMMARY OF OUTPUT

A discussion of BOPACE output is conveniently divided into two parts. The first covers output which is primarily an echo check of the input data, and the second covers output results for each load increment.

3.1 ECHO CHECK OF INPUT DATA

Initial Output - The first page of BOPACE output for a problem is essentially an echo check of input items C-1, C-2, C-3 and I-1. An indication is given as to whether the problem is being started or restarted. If it is restarted then the previous increment number is given, from the end of which the restart is progressing. Next the problem I.D. title is printed, followed by the various control constants which are determined from their default values or from input values C-3. Finally the input data from I-1 are printed.

<u>Material Properties</u> - For each material the three curves (thermal strain, elastic modulus and Poisson's ratio) input in data item I-2 are printed.

<u>Plasticity Data</u> - For each material the plasticity data input in data item I-3 are printed. These include the plasticity hardening type (1 = strain hardening, 2 = work hardening) and the kinematic hardening code (0, 1 for one, two parameter hardening, respectively). Following are groups of two or three curves given at each temperature (surface size $\bar{\sigma}$ - $\bar{\alpha}$ vs. cumulative hardening parameter κ , kinematic hardening curve shape vs. kinematic shape parameter κ^k , and kinematic curve magnitude vs. κ if given). The

hardening curves are input and output by order of associated low to high temperature. Abscissas of the curves in the first (lowest temperature) group are used as the basis for tabulating all curves, i.e., curve points of higher temperatures are interpolated to the low-temperature abscissas. These interpolated hardening curves are printed following printing of the input hardening curves.

<u>Creep Data</u> - For each material the creep data input in data item I-4 are printed. These include the creep hardening type (1, 2, 3 for age, strain, work hardening, respectively), and the reference creep curve shape of creep strain vs. time. Following are the creep factors for each combination of temperature and stress, grouped by low to high temperature. Stress values in the first (lowest temperature) group are used as the basis for tabulating all groups, i.e., creep factors at higher temperatures are interpolated to the low-temperature stress values. The interpolated hardening factors are printed following printing of the input hardening factors.

Special Coordinate Systems - These are the user-defined direction (special Cartesian) systems of input data item I-5. Quantities printed are the system I.D. number, and counter-clockwise angle (in degrees) from the basic X axis to the special-system x axis.

Node Definitions - The information given in input item I-6 is printed. Values are the node number, node I.D., location coordinate system number (0 = basic Cartesian, 1 = basic cylindrical), X or R coordinate, Y or θ

(degrees) coordinate, direction coordinate system number (0 = basic Cartesian, 1 = basic cylindrical, >1 = I.D. of special system).

Element Definitions - The information given in input item I-7 is printed. Values are the element number, element I.D., material number, element thickness, the three element node I.D. numbers in counter-clockwise order, and the computed element area.

Force-Displacement-Constraint Prescriptions - These are the codes given in input data item I-8. Quantities printed are the node I.D., the component number, and code for each degree of freedom with a user-specified force, displacement or constraint.

Mechanical Load Reference Vectors - For each input component of the two load vectors from input item I-9, the node I.D., component number, and load are printed.

Incremental Mechanical Load Data - Quantities related to input data item C-4 are printed. First is printed the number of load increments to be run. Then for each increment is given the increment number, input or default value for maximum number of iterations per increment, factors to be applied to the two load reference vectors, and the creep time increment.

3.2 RESULTS FOR EACH LOAD INCREMENT

Thermal and Z Loads - The cumulative values of thermal load and Z-direction mechanical load for each element, given in input item II-1, are printed. A heading gives the increment number, and is followed by the input I.D. title for the increment. Then the element I.D., cumulative temperature and cumulative Z load are printed, by groups of ten elements.

Iterative Error Values - An error norm computed at the end of each iteration is printed. The error norm is obtained by a ratio of unbalanced (residual) forces to "total" forces. The total forces are computed by summing a stress quantity times the thickness of each element, multiplied by the square root of the element area. This gives a meaningful error norm even if the applied loads do not include any forces.

Increment Heading - The load increment number is printed, along with the increment I.D. title given in input item II-1. Following this are the creep time increment, the number of elastic and plastic elements at the end of the increment, the number of elements which have changed elastic to plastic and plastic to elastic during the increment, the maximum allowable number of Jacobian updates and the number performed during this increment, the maximum allowable number of iterations per update and the number performed since the last update, and the maximum allowable error norm and the error norm actually obtained.

<u>Cumulative Forces and Displacements</u> - These are the cumulative internal forces (corresponding to computed element stresses) and displacements for

each node. The node number and node I.D. are printed, followed by the U and V components of force and displacement. U and V are in the directions defined by the node direction coordinate system (X-Y, R- θ , or special coordinate system).

Thermal and Elastic Strains - These are incremental and cumulative values of the thermal and elastic strains for each element. The element number and element I.D. are printed, followed by the thermal strains and components of the elastic strains. All strain components are referred to the element base coordinate system (an x-y right-hand Cartesian system with origin at node 1, and x axis along the nodal line 1-2).

<u>Plasticity Results</u> - For each element the number and I.D. are printed, followed by the incremental and cumulative plastic work and components of plastic strain. All strains are again given in the element base coordinate system.

<u>Creep Results</u> - These are printed only if the creep time increment (input in data item C-4) is greater than zero. Printed creep results correspond to those for plasticity.

Stress Results - For each element the number and I.D. are printed, followed by the values of cumulative effective stress center $\overline{\alpha}$ and effective stress $\overline{\sigma}$, and the components of stress center and stress referred to the element base coordinate system.

Summarized Element Quantities - For each element the number and I.D. are printed, followed by the elastic-plastic "code" and "sum code." The code is 0, -1 or +1, respectively, according to whether the element condition has remained unchanged, gone from plastic to elastic (unloaded), or gone from elastic to plastic (yielded) during the increment. The sum code gives the value for the program variable YCODE1, and is + or -, respectively, according to whether the element condition is plastic or elastic at the end of the increment. Its magnitude is an indication of the iterative tendency for the element to remain in that condition. Next are given the total temperature and the yield surface size $(\overline{\sigma} - \overline{\alpha})$ at the end of the increment. Finally are printed, for both plastic and creep strains, three values of effective strain (incremental $\Delta \overline{\epsilon}$, sum of incremental $\Delta \overline{\epsilon}$, and cumulative $\overline{\epsilon}$).

4.0 SIZE LIMITATIONS

4.1 GENERAL SIZE LIMITATIONS

The following variables are used to specify maximum size limitations in BOPACE. The values set for these variables in the 300-DOF and 1000-DOF program versions are given in Table 4.1-1.

NSTOR = core words allocated to Gauss wavefront storage

NMAX1 = maximum number of materials

NMAX2 = maximum number of nodes

NMAX3 = maximum number of elements

NMAX4 = maximum node I.D. number

NMAX5 = maximum element I.D. number

NMAX6 = maximum number of points in a material property curve

NMAX7 = maximum number of temperature plasticity curves per material

NMAX8A = maximum number of points per isotropic hardening curve

NMAX8B = maximum number of points per kinematic hardening shape curve

NMAX8C = maximum number of points per kinematic hardening factor curve

NMAX9 = maximum number of points in a creep reference curve

NMAX10 = maximum number of creep-factor temperatures per material

NMAXII = maximum number of creep-factor stresses per temperature

NMAX12 = maximum number of special coordinate systems

NMAX13 = maximum (required) number of mechanical load reference vectors

NMAX14 = maximum number of load increments per run

TABLE 4.1-1: MAXIMUM SIZE LIMITATIONS

<u>Maximum</u>	300 DOF	1000 DOF
NSTOR	2000	5000
NMAX1	5	5
NMA X2	150	500
NMAX3	200	800
NMA X4	500	2000
NMAX5	1000	3000
NMAX6	20	20
NMAX7	6	6
NMAX8A	30	30
NMAX8B	20	20
NMAX8C	30	30
NMAX9	10	10
NMAX 10	6	6
NMAX11	10	10
NMAX12	50	50
NMAX13	. 2	2
NMAXT4	60	60

4.2 LINEAR EQUATION SOLVER LIMITATIONS

The linear equations solution routines have one user controlled limitation. This is the maximum bandwidth of active nodes during the decomposition of the stiffness matrix. The bandwidth is defined as the number of nodes following the node being processed which have non-zero terms associated with the node being processed. Melosh and Bamford [1] discuss this in some detail as the wavefront analysis concept. Whetstone [2] also discusses this concept and gives rules and procedures which can be used to keep the bandwidth as small as possible by proper numbering of the nodes.

BOPACE uses the maximum active bandwidth (wavefront) to determine core storage requirements during decomposition.

Let

K = the amount of storage available (K = 2000 for the 300 DOF version, K = 5000 for the 1000 DOF version)

N = the number of DOF per node (a constant for each node in the analysis)

B = the maximum active bandwidth

 $T = B + B * N^2 + 4$

M = B * (B+1)/2

Then the following two equations must be satisfied:

$$T \leq 420 \tag{4.2-1}$$

$$K \ge B + M + 2*N^2*M + 6*N^2 + T$$
 (4.2-2)

5.0 DETAILED INPUT AND STORAGE OF DATA

5.1 DETAILED INPUT DESCRIPTION

This section provides a definition of BOPACE input variables, and a detailed description of the input data and their use within the program.

Data are discussed in the order in which they are read, with data item numbers corresponding to those given in Section 2.0.

Input Files - In addition to the usual card file (unit number 5), BOPACE uses files I and II for which the user defines unit numbers. Because the data on these files may become rather lengthy for a large-size problem, the user may wish to define them as tape files which are automatically generated by special subroutines. (See for example Appendix A, for a description of the INPUTB interpolation-data-generator program.) File I data define the basic problem, mesh and material properties. These data cannot be redefined during solution of the problem, so that they are independent of any particular load increment and are used only when starting a new problem.

- C-1. Start-Restart Code and Data File Numbers These data are read by subroutine READRS from the usual card file (unit number 5):
 - a. START = start-restart code
 - b. UIN1 = unit number for input file I
 - c. UIN2 = unit number for input file II
 - d. UOUT = unit number for output file (e.g., printer)

5.1 (Continued)

- e. INCR = previous increment number from the end of whicha restart is to be made
- f. UINRS = unit number for input restart tape
- q. UOUTRS = unit number for output restart tape

A "RESTART" code specified in item (a) means that an input restart tape is being provided (item f), which contains the initial Jacobian and its decomposition, the basic problem, mesh and material data, and previous incremental results including those for increment INCR (e) from which a restart is to be made. If INCR = 0, the problem is started from the initial conditions, but the reading of the file I data and the formation and decomposition of the initial Jacobian are avoided. If neither "START" nor "RESTART" is specified, it is assumed that the blank card of input item C-5 (see Section 2.0) has been read, and the program exits in the normal mode with a STOP 9999 code.

The file unit number (b) is required when starting. Unit numbers (c) and (d) are required in all cases. If the current run is a restart, the unit number (f) is required. If results are to be saved for a future restart, the unit number (g) is required.

C-2. Problem I.D. Title - The title is read by subroutine READO:

IDENT = problem I.D. title

The title consists of any 80 characters used to describe the current run.

C-3. Program Control Constants - These constants are read by subroutine READO:

a. SCODE = code for system matrix (Jacobian) updating

b. MAXUP = maximum number of updates per increment

c. MAXIT = maximum number of iterations per update

d. MAXIE = maximum number of initial elastic iterations

e. MAXYC = maximum allowable magnitude for YCODE1

f. MAXCUT = maximum number of cuts

g. CUT = cutting fraction

h. ERRMAX = maximum allowable error norm

i. AFACT = increment fraction for evaluating hardening slope

The value of SCODE (item a) is the code for updating the Jacobian and its component matrices. It allows various options for the basic solution approach, depending on the amount of nonlinearity expected in the problem. It affects only the rate of convergence and the effectiveness of the iterative process. It does not alter the manner in which unbalanced forces are iteratively computed, nor does it affect the final computed results so long as convergence is achieved. A discussion of the effects of each option for various types of problems is given in Section 4.4 of the BOPACE Theoretical Manual. Item (b) gives the maximum number of Jacobian updates per load increment. An update is performed if the maximum number of iterations specified in (c) has been reached without achieving convergence.

Generally a maximum of one update per increment is sufficient, unless very large changes in the elastic properties, slope of the stress-strain curve, or direction of loading, have occurred.

Item (d) gives the maximum number of iterations to be performed at the start of the increment, using the current elastic matrix. These initial iterations are performed in order to account for the possible occurrence of large-scale unloading within the structure.

MAXYC (item e) gives the maximum absolute value for the elastic-plastic sum code, YCODE1. The current value of YCODE1 for each element determines whether it is to be treated as elastic or plastic in the calculation of unbalanced forces and in the formation of the Jacobian stiffness matrix (0 or - denotes elastic condition, + denotes plastic condition). YCODE1 is changed by -1 or +1 after each iteration, depending on whether the condition was determined to be elastic or plastic, respectively, but its absolute value is not allowed to exceed MAXYC. If the value of YCODE1 reaches 0, the element condition is considered to have changed and YCODE1 is set to an initial value of ±2 (±2 is used instead of ±1 because it prevents oscillation between elastic and plastic conditions in certain cases). The purpose of YCODE1 is essentially to denote the element condition and to provide a stabilizing influence on the iterative process. Higher specified values of MAXYC could increase the stability but might require larger convergence times.

Items (f) and (g) (MAXCUT and CUT) relate to a common method for increasing the stability of iterative processes. If a computed displacement correction in the BOPACE iteration does not result in a decreased error norm, then the error norm is computed for another configuration based on some fraction of the displacement correction. If the error norm still has not decreased, the fraction is squared and again applied to the displacement correction, etc. MAXCUT gives the maximum number of such "cuts" to be performed, and CUT gives the fraction to be used.

Item (h) gives the maximum allowable error norm. The actual error norm is computed essentially as a ratio of unbalanced forces to applied forces.

AFACT (item i) relates to evaluation of the plastic hardening slope for each element, used in forming the Jacobian matrix. The best location for evaluating this slope for the Jacobian update is a point at the <u>end</u> of the current increment. The actual slope is determined in BOPACE using two interpolated values from the hardening tables. The second corresponds to the estimated value of the hardening parameter at the end of the increment, while the first is at a small distance prior to the second and is determined by subtracting the fraction AFACT times the incremental change in the hardening parameter.

I-l. Basic Constants and Default Values - These items are read by subroutine READ1:

PCODE = plane-stress or plane-strain code

NMAT = number of materials

THICK = default thickness

TEMPO = fabrication temperature

The code for plane-stress or plane-strain holds for all elements and defines the type of problem being run. The default thickness defines the thickness of all elements, unless it is overidden by the element values given in I-7. The fabrication temperature defines the initial temperature of the structure, at which thermal strains are considered to be zero. It is also the default temperature for all elements during the first load increment, unless it is overridden by the element values given in II-lb.

I-2. Material Property Data - These data are read by subroutine READTM:

NTHERM(I) = number of points in thermal-strain curve for material I

THERMX(J,I) = Jth temperature value of thermal-strain curve for material I

THERMY(J,I) = Jth thermal strain value for material I

- EMODY(J,I) = Jth elastic-modulus value for material I
- NPRAT(I) = number of points in Poisson's ratio curve for material I
- PRATX(J,I) = Jth temperature value of Poisson's ratio curve for material I
- PRATY(J,I) = Jth Poisson's ratio value for material I

The property data are given consecutively for each material. The zero-strain point of the thermal-strain curve is arbitrary, because the curve is used only to obtain the <u>increment</u> of thermal strain corresponding to a given temperature increment. All interpolation performed later from the thermal-strain, elastic-modulus and Poisson's ratio curves is accomplished by the linear interpolation routine YVAL.

<u>I-3. Plasticity Data</u> - The plasticity data are given consecutively for each material. The data are read by subroutine READTP:

- PTYPE(I) = plastic hardening type for material I
- $\mathsf{KTYPE}(I)$ = kinematic hardening code for material I
- NTABY(I) = number of temperature values for hardening tables for material I

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5.1 (Continued)

- NITABX(I) = number of κ values for isotropic hardening table for material I
- ITABX(J,I) = $Jth ext{ } ext{$\kappa$ value for isotropic hardening table for }$ material I
- ISTAB(K,J,I) = value of isotropic hardening table for Kth temperature value and Jth κ value for material I
- NKTABX(I) = number of κ^k values for kinematic hardening shape table for material I
- $KTABX(J,I) = Jth \kappa^k$ value for kinematic hardening shape table for material I
- KSTAB(K,J,I) = value of kinematic hardening shape table for Kth temperature value and Jth κ^k value for material I
- NFTABX(I) = number of κ values for kinematic hardening factor table for material I
- FTABX(J,I) = Jth κ value for kinematic hardening factor table for material I
- FSTAB(K,J,I) = value of kinematic hardening factor table for Kth temperature value and Jth κ value for material I.

PTYPE defines for each material whether it is a strain-hardening or work-hardening material. KTYPE defines whether the kinematic hardening for each material is to be taken as a function of only the parameter κ^k , or of both κ^k and κ . Two-parameter kinematic hardening accounts for change in magnitude of the Bauschinger effect with continued cycling, i.e., with increase in value of κ .

Hardening is defined by values stored in the three hardening tables ISTAB, KSTAB and FSTAB. ISTAB gives the size of the yield surface $(\overline{\sigma}-\overline{\alpha})$. KSTAB gives the shape of the kinematic hardening $(\overline{\alpha})$ curve, and FSTAB gives the factor to be applied to this shape in order to define the variable Bauschinger effect. The values in these 2-dimensional tables (for each material) represent a series of hardening curves at various temperature levels. TABY defines the temperature series which is used for all three hardening tables. However, each table has its own set of values for hardening parameter, defined by the respective vectors ITABX, KTABX and FTABX for each material. When, for example, the κ -parameter ITABX and the temperature value TABY are given for a particular material, the corresponding size of the yield surface is determined by double interpolation from the table ISTAB.

The hardening curves are input in order of associated low to high temperature. The curve at each temperature may have its own series of κ or κ^k parameters. However, a single series of these parameters (defined

by ITABX, KTABX or FTABX) is needed for each hardening table. This series is taken as that given for the low-temperature curve of the table, and curves for other temperatures are interpolated to these basic values. Therefore the low-temperature curve input for each table should cover the range of parameter values used in all curves input for that table, in order to avoid losing any points in the initial interpolation and forming of the table. Later interpolation from the plastic hardening tables is accomplished by the double linear interpolation routine ZVAL.

For KTYPE = 0, kinematic hardening is determined using only the KSTAB table, and the FSTAB table and associated data are not read. For KTYPE = 1, kinematic hardening is determined as a product of values from the shape table KSTAB and the factor table FSTAB. A more detailed description of the BOPACE plastic hardening method is given in Section 2.3 of the Theoretical Manual.

<u>I-4. Creep Data</u> - The creep data are given consecutively for each material.

The data are read by subroutine READTC:

CTYPE(I) = creep hardening type for material I

NCREEP(I) = number of points in reference creep curve for material I

CREEPX(J,I) = Jth time value of reference creep curve for material I

CREEPY(J,I) = Jth creep-strain value of reference creep curve for material I

NCTABX(I)	=	number of stress values for creep factor table
		for material I
NCTABY(I)	=	number of temperature values for creep factor
		table for material I
CTABX(J,I)	=	Jth stress value for creep factor table for
		material I
CTABY(J,I)	=	Jth temperature value for creep factor table
		for material I
CTAB(K,J,I)	=	value of creep factor table for Kth temperature
		value and Jth stress value for material I

CTYPE defines for each material whether it is an age-hardening, strainhardening or work-hardening material with respect to creep.

Shape of the creep curve is defined by the vectors CREEPX and CREEPY for each material. Creep factors are stored in the 2-dimensional table CTAB. CTABY defines the temperatures associated with these factors, and CTABX defines the stress levels. Later interpolation from the CTAB factor table is accomplished by the double linear interpolation routine ZVAL. Interpolation from the shape vector CREEPY is accomplished by the linear incremental interpolation routine DYVAL, which gives the increment of strain on the reference creep curve corresponding to given initial and final values of time. The actual increment of effective creep strain is determined as a product of the CTAB factor and the CREEPY shape increment.

Each input creep hardening factor has an associated temperature and stress level. The factors are input in temperature groups, in order of low to high temperature, and within each group are ordered from low to high stress level. Although each temperature group may have its own input stress-level series, the stress-level series defined by CTABX is used for all temperatures during later interpolation. CTABX is taken as the stress series given for the low-temperature group of factors, and other groups are interpolated to these basic values. Thus the input low-temperature group should cover the range of stress values input for all groups, in order to avoid losing any points in the initial interpolation and forming of the factor table.

<u>I-5. Special Coordinate Systems</u> - The special coordinate systems are read by subroutine READC:

COORDA(I) = angle for special coordinate system I

These systems provide special nodal direction coordinates which can be used to specify components of force or displacement in a particular direction.

I-6. Nodal Data - These data are read and computed by subroutine READM:

NOD = number of nodes in problem

COORD(J,I) = Jth (X or Y) coordinate for node I

GCOS(J,I) = Jth direction Cosine for node I

NODE(I) = node I.D. for node I

NODI(I) = node number for node I.D. I

The value of NOD is determined by the program from counting the input nodal data. When the two coordinates for a node are read, they are converted to basic Cartesian (X-Y) coordinates and stored in the COORD array. The GCOS direction Cosines are the Cosine and Sine, respectively, of the angle from the basic X axis to the nodal direction coordinate system X axis. The GCOS array is computed and stored in double precision, so as to avoid loss of accuracy. This precision is required in problems such as those involving a small cylindrical segment of an engine wall, where quantities involving the Sine and Cosine of very small angles are important.

The node I.D. is supplied by the user, and actual internal node numbers are assigned consecutively in the order in which nodes are read in the input data deck. Since the internal numbers are used in all operations including formation and solution of the linear equations, the user should attempt to place the nodes in the data deck in an efficient order, i.e., an order which avoids as much as possible the connection of nodes having greatly different internal node numbers.

I-7. Element Data - These data are read and computed by subroutine READM:

NEL = number of elements in problem

IMAT(I) = material number for element I

T(I) = thickness of element I

ELNO(J,I) = Jth node number for element I

NELE(I) = element I.D. for element I

NELI(I) = element number for element I.D. I

The value of NEL is determined by the program from counting the input element data. The ELNO array stores the three internal node numbers for each element in counter-clockwise order.

The element I.D. is supplied by the user, and actual internal element numbers are assigned consecutively in the same manner as for nodes. In order to increase the efficiency of the global matrix formations, it is best to have the order of elements in the data deck follow approximately the order of the nodes to which they are connected.

<u>I-8. Force-Displacement-Constraint Specifications</u> - These data are read by subroutine READ2:

KFD(I) = force-displacement-constraint code for degree of freedom I

The degrees of freedom are ordered by node number, e.g., KFD(5) is the code for the first degree of freedom at node 3 (2 DOF per node). Each DOF has either a specified force or displacement. For the usual type of structure, most will be specified forces. For a constrained DOF,

i.e., a dependent DOF whose displacement is set equal to that of some independent DOF, the program makes its code agree with that of the independent DOF. Thus if the independent DOF has a specified force, the dependent DOF will have a specified (perhaps zero value of) force; if the independent DOF has a specified displacement, the dependent DOF by definition has the same displacement.

A DOF may not be constrained with a dependent (already constrained) DOF.

Also, the present BOPACE equation-solver routines do not allow constraints between two nodes on the same element.

I-9. Mechanical Load Reference Vectors - These data are read by subroutine READ3:

PREF(J,I) = load component of Jth (1st or 2nd) load reference

vector for DOF I

The load components are given in the directions defined by the node direction coordinate systems. The current version of BOPACE employs two load reference vectors. In order to simplify input, the cumulative loads (specified forces and displacements) at the end of each load increment are computed as the sum of the two load factors times their respective load vectors. Thus the two load vectors remain constant throughout the entire problem. For engine problems, the two vectors typically define the pressure distributions in the chamber and coolant tubes, respectively.

Although the present program does not allow the load distribution within a load vector to vary from one increment to the next, the two Moad factors may of course vary independently of one another.

C-4. Incremental Mechanical Load Data - These data are read by subroutine READ4:

NINCR = number of load increments to be run

NITER(I) = maximum number of iterations for increment I

PFACT(J,I) = load factor to be applied to load reference vector

J during Ith increment

CTIME(I) = creep time increment for load increment I

II-1. Thermal and Z-Direction Loads - These data are read by subroutine READ5:

TIDENT = increment I.D. title

Tl(I) = cumulative (total) temperature at end of increment

for element I

ZS1(I) = cumulative Z load at end of increment for element I

The increment title consists of any 80 characters used to describe the current load increment. Before the thermal and Z loads are read for an increment, Tl and ZSl are set equal to their values at the beginning of the increment (TO and ZSO, respectively). This provides default loads (unchanged from those of the previous increment) for those elements for

which the user does not specify a load value. The thermal and Z loads are then read according to data items II-lb and c, in any desired element order.

5.2 I/O AND STORAGE FILES

The following are descriptions of files used in the BOPACE program, listed by unit number.

<u>5</u>

Input card file.

<u>6</u>

Output printer file.

UINI

UIN1 is the user-defined unit number for type I input data.

UIN2

UIN2 is the user-defined unit number for type II input data.

TUOU

UOUT is the user-defined unit number for the major output data file.

UINRS

UINRS is the user-defined unit number for the input restart data file.

UOUTRS

UOUTRS is the user-defined unit number for the output restart data file.

UNITE1 = 11

File for storing the merged elastic stiffness matrix.

UNITE2 = 12

File for storing the decomposed elastic stiffness matrix.

UNITP1 = 13

File for storing the merged total Jacobian matrix. It is used only when the input variable SCODE is equal to 3, 4 or 5.

UNITP2 = 14

File for storing the decomposed total Jacobian matrix. It is used only when the input variable SCODE is equal to 3, 4 or 5.

UNITSI = 15

Scratch file used for temporary storage by the Gauss wavefront merge and decomposition routines.

UNITS2 = 16

Same as UNITS1.

6.0 PROGRAM FLOW AND RESTART OPTIONS

The major steps accomplished during a BOPACE run are shown in the program flow summary of Figure 6.0-1.

Steps 3-7 accomplish the initialization of basic variables (program control constants, material data, mesh, and load vectors) and incremental variables, and the formation of merged and decomposed elastic stiffness matrices. These steps follow from reading of input data in the case where a new problem is being started, or from reading of the input restart tape in the case of a restart. If data is to be saved for a future restart, steps 9-10 write the basic variables and elastic merged and decomposed matrices onto the output restart tape. In step 11 the incremental mechanical load data, including load factors and creep time increment for each load increment to be run, are read.

The remaining steps involve the incremental and iterative calculations.

Updating of the Jacobian matrices in step 23 is performed only when convergence slows down, and in general this occurs only once per increment or once every several increments.

In step 26 the computed incremental variables are written onto the output restart tape, if a future restart is provided for. This allows the user to request a restart from the end of any previously run load increment.

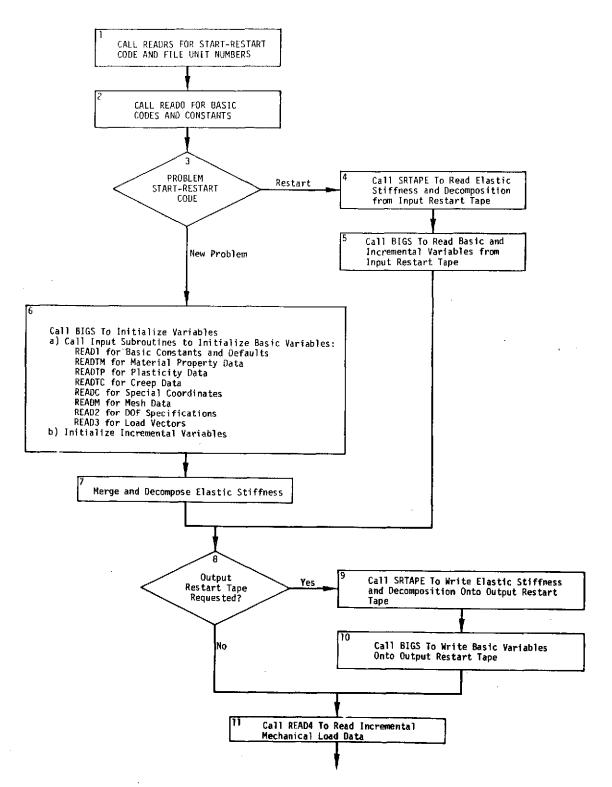


Figure 6.0-1: PROGRAM FLOW

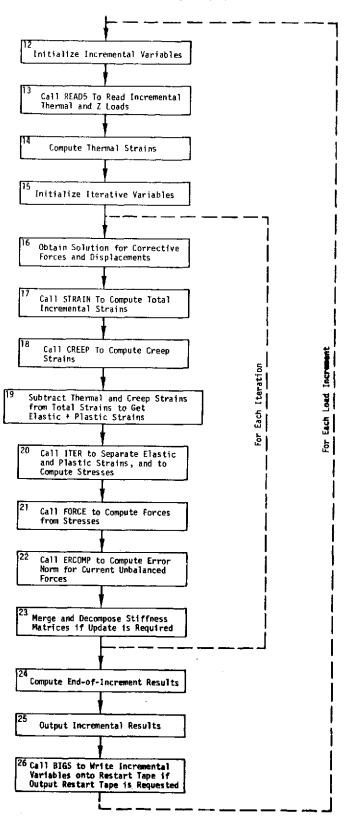


Figure 6.0-1: PROGRAM FLOW (CONTINUED)

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7.0 BOPACE ERROR MESSAGES

BOPACE uses the FORTRAN STOP codes described in this section to indicate error conditions which may occur during execution of the program. Certain errors also generate a printed error message, in order to aid the user in locating the source of the error.

Errors fall into two categories, those due to the problem definition or user input data, and those caused by a program or machine malfunction. Errors due to a machine malfunction rarely occur and in these cases a rerun of the problem will usually eliminate the error. If an error recurs and help is needed in correcting the problem, contact a BOPACE programmer for aid. Have available a listing of the input data, the printouts of the runs which failed, the input data deck, and a description of the problem.

The following are explanations of the BOPACE error STOP codes, listed by subroutine in which they occur.

READRS

- 9999 Normal program exit caused by reading final blank card after all problems are run.
- Non-positive value input for a required file unit number.

READ1

- 201 Plane stress-strain code input not equal to 0 or 1.
- 202 Illegal value input for number of materials.

READTM	
301	Wrong material number input on material property card.
302	Number of points input for material property curve exceeds maximum
303	Non-positive value input for modulus of elasticity.
304	Value input for Poisson's ratio is 0.49 or greater in plane-strain problem.
305	No points input for a required material property curve.
READTP	
401	Wrong material number input on plasticity type-code card.
402	Illegal plasticity type input.
403	Illegal kinematic hardening code input.
404	Wrong material number input on plasticity temperature card.
405	Plasticity temperatures not in ascending order.
406	Number of temperatures for a material exceeds maximum.
407	Hardening point defines non-positive yield-surface size, or negative kinematic value.

READTP	
408	Number of points input for a curve exceeds maximum.
409	No points input for a required curve.
410	First point input on a curve has non-zero abscissa.
411	No curves input for a required hardening description of a material.
READTC	
501	Wrong material number input on creep type card.
502	Illegal creep type input.
503	Number of points input for a creep reference curve exceeds maximum.
504	No points input on the creep reference curve for a material.
505	Wrong material number input on creep temperature card.
506	Creep temperatures not in ascending order.
507	Number of creep temperature factors for a material exceeds maximum.
508	Number of creep stress factors at a temperature exceeds maximum.

READTC

No creep stress factors input at a temperature.

No creep temperatures input for a material.

READC

I.D. of special coordinate system exceeds maximum.

READM

701 Mesh node I.D. exceeds maximum.

702 I.D. of a node location coordinate system not equal to 0 or 1.

703 I.D. of a node displacement coordinate system exceeds maximum.

704 Number of input nodes exceeds maximum.

705 No nodes input.

711 Element I.D. exceeds maximum.

712 Illegal value input for element material number.

713 Illegal node I.D. on an element.

714 Number of input elements exceeds maximum.

715 No elements input.

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7.0 (Continued)

DEAD2	
READ2	
801	Illegal node I.D. for a force-displacement-constraint
	specification.
802	Illegal component number (not equal to 1 or 2)
803	Illegal force-displacement-constraint code.
804	Constraint specified with dependent (already constrained)
	DOF.
805	Constraint specified between DOF on same element.
READ3	
901	Number of input mechanical load reference curves not
	equal to 2.
902	Illegal node I.D. on a mechanical load.
903	Illegal component number (not equal to 1 or 2) on a
	mechanical load.
904	Load input on dependent DOF constrained to DOF with
- - -	specified displacement.
	opastitua wish (wound) ()
READ4	

KE AU4

Number of load increments exceeds maximum per run.

READ5

1101 Illegal element I.D. on a thermal load.

1102 Illegal element I.D. on a z-load.

Linear Equation-Solver Routines

I/O Error during merge. Program or machine malfunction during the merging of the elemental stiffness matrices to form the global stiffness matrix.

Bandwidth too large for decomposition save array.

The bandwidth is too large for the amount of core storage allocated (see Equation 4.2-1). Corrective action: renumber the nodes to reduce the bandwidth.

No decomposition partitions available. Program or machine malfunction during decomposition.

Decomposition node not in active node array. Program or machine malfunction during decomposition.

Scratch array too small for solution work. Program or machine malfunction during forward and backward substitution.

Illegal save tape I/O operation command. Program or machine malfunction in reading or writing the checkpoint tape.

Linear Equation-Solver Routines

- Illegal matrix type. Program or machine malfunction in reading or writing the checkpoint tape.
- Illegal save tape defined for save operation. Program or machine malfunction in reading or writing the checkpoint tape.
- Large decomposition not available. The bandwidth is too large to solve the problem using in-core decomposition.

 See Equation 4.2-2. Corrective action: Reduce the bandwidth by renumbering the nodes or reducing the problem size.

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8.0 REFERENCES

- 1. R. J. Melosh and R. M. Bamford, "Efficient Solution of Load-Deflection Equations," Journal of the Structural Division, ASCE, April 1969.
- 2. W. D. Whetstone, "Computer Analysis of Large Linear Frames," Journal of the Structural Division, ASCE, November 1969.

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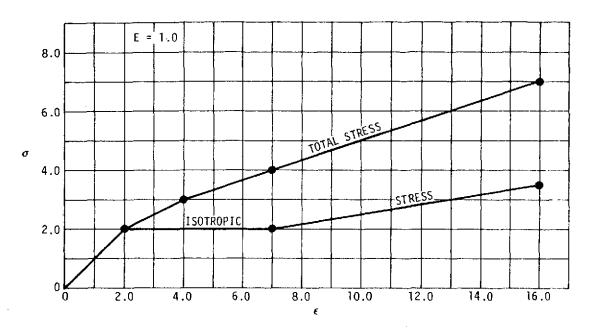
9.0 EXAMPLE PROBLEMS

Four example problems are provided here in order to demonstrate the BOPACE program capabilities and to aid the user in setting up his problems. The examples in Section 9.1 serve to demonstrate and check out various program options, including temperature-dependent elasticity, creep and prescribed normal loads. Section 9.2 illustrates a thermal ratchet behavior, which must be considered as a possible important effect during any combined mechanical loading and high-temperature thermal cycling. Section 9.3 illustrates the procedure for using actual cyclic test data to determine the isotropic and kinematic portions of hardening, and gives an indication of the test-analysis match which is possible with the BOPACE combined hardening approach. Section 9.4 gives an example of the required input data for a typical engine analysis, involving a relatively coarse finite-element mesh but with several different materials.

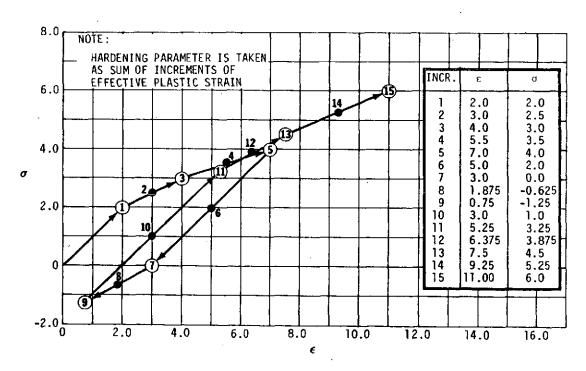
9.1 PROGRAM CHECKOUT PROBLEMS

Plane Stress with Combined Hardening - The basic characteristics of BOPACE combined hardening are shown in Figure 9.1-1 for a uniaxial (special case of a plane-stress) problem. Figure 9.1-1A gives the assumed monotonic stress-strain hardening curves. The size of the yield surface is defined by the isotropic stress, while the Bauschinger kinematic hardening is defined by the difference between the total stress and the isotropic stress. Thus the hardening is completely kinematic out to a strain value of 7.0 (plastic strain of 3.0), after which there are equal amounts of isotropic and kinematic hardening.

A resulting cyclic stress-strain curve is given in Figure 9.1-1B. The 15 load increments were chosen so as to result in the exact σ - ϵ points given in the figure insert table. Note that the hardening parameters (κ and κ^k) in this example were based on effective plastic strain rather than on plastic work, because it makes the relationship between the monotonic and cyclic curves more readily apparent.



(A) MATERIAL STRESS-STRAIN CURVES



(B) STRESS-STRAIN PATH UNDER LOADING

FIGURE 9.1-1: UNIAXIAL TEST PROBLEM FOR CYCLIC COMBINED HARDENING

<u>Plane-Strain with Additional Options</u> - The plane-stress problem just described was altered to illustrate the use of several additional BOPACE options, including temperature-dependent elasticity, creep and prescribed normal loads.

A BOPACE plane-strain checkout analysis was performed using the finiteelement mesh and loading given in Figure 9.1-2. A listing of the input data and the printed output results are included at the end of this section.

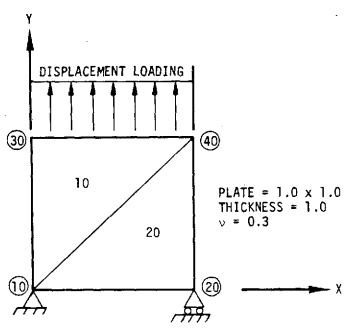


FIGURE 9.1-2: PLANE-STRAIN CHECKOUT PROBLEM

A summary of the problem is provided by Table 9.1-1. The 15 increments correspond to those of the previous plane-stress problem. The values of incremental plastic strain, stress, effective stress center, and yield-surface size given in columns 2-5 of Table 9.1-1 were kept the same as those of the plane-stress problem. The stress is equal to the product of the temperature-dependent elastic modulus (column 6) and the elastic strain (column 7).

The creep strain listed in column 9 results from the material creep definition of Figure 9.1-3. There the reference creep curve for a strain-hardening material is assumed as shown in (A), while (B) defines the creep factor F^C as a function of average stress level during the increment. The creep strain may be determined using the average stress level (column 10 of Table 9.1-1), the creep factor (column 11) and the specified creep time increment (column 12).

In addition, the Z-load strains given in column 13 and thermal strains in column 14 were imposed. In order to keep the results simple and exact (all numbers in Table 9.1-1 are given exactly), the Z-load and thermal-strain values were selected so as to give zero normal stress in each increment. For example, in increment 11 we have:

$$\varepsilon_{ZZ}^{e} = -0.3$$

$$\varepsilon_{ZZ}^{p} = -1.0$$

$$\varepsilon_{ZZ}^{c} = -0.5$$

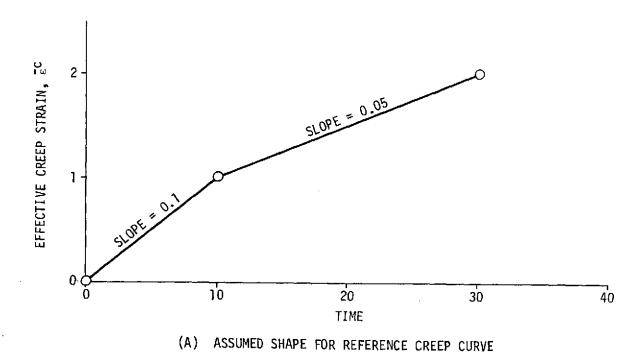
$$\varepsilon_{ZZ}^{t} = 1.5$$

$$\Sigma \varepsilon_{77} = -0.3$$

Because the imposed Z-load strain also equals -0.3, a zero value results for the normal stress σ_{ZZ} . Thus it may be noted that this example can be used for either a plane-stress or a plane-strain checkout run.

The prescribed displacements shown in column 15 were determined from the various components of the total strain. For example, again in increment 11:

$$\epsilon_{\gamma\gamma}^{e} = 1.0$$
 $\epsilon_{\gamma\gamma}^{p} = 2.0$
 $\epsilon_{\gamma\gamma}^{c} = 1.0$
 $\epsilon_{\gamma\gamma}^{t} = 1.5$
 $Q_{\gamma\gamma} = \Sigma \epsilon_{\gamma\gamma} = 5.5$



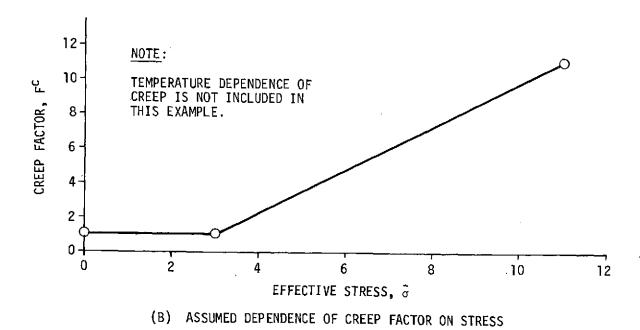


FIGURE 9.1-3: CREEP DEFINITION FOR PLANE-STRAIN CHECKOUT PROBLEM

IABLE 9.1-1:	KE20F12	FUK	PLANE	ZIKATN	MILH	Z-LUAUS	ANU	CKEEP	

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Incr.	∠e p	σγγ	3 2° yy	5-a	El	_د e ۲۲	ε <mark>γγ</mark>	ε <mark>ς</mark>	o ave	₽ ^C	۵t ^c	z-load strain	£	Q _{YY}	Temp.
0	-	0	0	2.0	1.0	0.	0	0			-	0	0	0_	1.0
1	0	2.0	0	2.0	2.0	1.0	• 0	0	1.0	1.0	0	G	0.3	1.3	2.0
2	0.5	2.5	0.5	2.0	2.5	1.0	0.5	0.5	2.25	1.0	5.0	0	0.8	2.8	3.0
3	0.5	3.0	1.0	2.0	3.0	1.0	1.0	0.5	2.75	1.0	0	0	1.05	3.55	4.0
4	1.0	3.5	1.5	2.0	3.5	1.0	2.0	1.0	3.25	1.25	4.0	0	1.8	5.8	5.0
5	1.0	4.0	2.0	2.0	4.0	1.0	3.0	1.0	3.75	1.75	0	0	2.3	7.3	6.0
6	0	2.0	2.0	2.0	2.0	1.0	3.0	1.0	3.0	1.0	0	0	2.3	7.3	7.0
7	0	0	2.0	2.0	1.0	0	3.0	1.0	1.0	1.0	0	0	2.0	6.0	5.4
8	-0.5	-0.625	1.5	2.125	1.25	-0.5	2.5	1.0	0.3125	1.0	0	-0.6	1.0	4.0	8.0
9	-0.5	-1.25	1.0	2.25	1.25	-1.0	2.0	0	0.9375	1.0	10.0	- 0.2	0.5	1.5	9.0
10	0	1.0	1.0	2,25	2.0	0.5	2.0	0	0.125	1.0	0	0	1.15	3.65	10.0
11	0	3. 25	1.0	2.25	3.25	1.0	2.0	1.0	2.125	1.0	10.0	-0.3	1.5	5.5	4.5
12.	0.5	3.875	1.5	2.375	3.875	1.0	2.5	1:0	3.5625	1.5625	0	0	2.05	6.55	12.0
13	0.5	4.5	2.0	2.5	4.5	1.0	3.0	1.0	4.1875	2.1875	0	0.2	2.5	7.5	13.0
14	1.0	5.25	2.5	2.75	5.25	1.0	4.0	1.0	4.875	2.875	0	0	2.8	8.8	14.0
15	1.0	6.0	3.0	3.0	3 .0	2.0	5.0	4.125	5.625	3.625	10.0	0	5.1625	16.2875	15.0

1	1 1.0	1.0	1 0.5	.00001			CEPT 05/08/7				
	. 1									··	
1.0	0+0 1+5	2+0 5+0	C.3 1.8	3.0 5.0	0. ? 2. ¹	4.0 7.0	1.05 2.3				
1•5 1•0	1.0	9.0	0.5	10.0	1.15	12.0	2.05		 		
3.0	2.5	14.0	2.8	15.0	5, 1525				···		
0	1.0	2.0	2,0	3.0	2.5	4.0	2.3		•		
. 0	3.5	5.4	1.0	6.0	4.0	7.0	2.0				•
3.0	1.25	0.0	1. 25	10.0	2.0	12.0	7,475				
13.0	4.5	14.0	5. 25	15.0	3.0				•		-
•0	0.3									·	
	1 0,	1						······································			
•0	2.0	3.0	2.0	9,0	3.5					· · · · · · · · · · · · · · · · · · ·	<u> </u>
0.0	0.0	1.0	1.0	3.0	2.0	9.0	3 K			.	
		2							·		
•0	0.0	10.0	1.0	30.0	2. 0						
0.0	1 0.0	3.0	1.0	11.0	9.0	,			,	-	
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30 40	0.0 1.0	1.0									
10	0.0	0.0									
20	1.0	0.0									
20	1	20	40 10								
10	<u>i</u>	10	40 30						·		
10	1 -10	10	2 -10	20	2 = 20						
30	2 -30	40	2 -40							,	· ·
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30	2 1.0										
40	2 1.0										
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	1.3		C. 0	· · · · ·							
	2 · 8 3 · 55		5.0 0.0					 			
·	5.8		4.0								
	7. 3		0.0								
	7.3		C. 0								·
	6.0 4.0		0.0 0.0								
	1.5		10.0								· · · · · · · · · · · · · · · · · · ·
	3 · 65 5 · 5		0.0						_ _		

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7.5		c. c							
8.8 16.287	<u> </u>	0.0 10.0							
INCREMENT	1								
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THENEMENT	7								
INCREMENT 10 3.0		29 3.0	· · · · · · · · · · · · · · · · · · ·		···········				
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INCREMENT	3					•			
10 4.0		20 4.0							
INCREMENT	4								
10 5.0		20 5.0				v			
INCREMENT	c							· 	
1 C 6. C		20 6.0							
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INCREMENT 10 7.0	6								
10 7.0	:	20 7.0							
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INCREMENT 10 5.4		20 5.4						· · · · · · · · · · · · · · · · · · ·	-5
<u></u>									D5-17266-2
	p								6-2
INCREMENT 10 8.0		20 R.O							
10 -0.6		20 ~0.6							
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INCREMENT 10 9.0	9	20 9.0				-			
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10 -0.2		20 -0.2	<u> </u>		- ·- ·				
INCREMENT 10 10.0	_ 10								
10 10.0		20 16.0				•			
10 0.0		2C 0.0							
INCREMENT	11								
10_4.5		70 4.5			·· <u>-</u> - <u></u> - <u>-</u>	·	·_ ·		
10 -0.3		20 -0.3							
							·		
INCREMENT 10 12.0	- 1/	20 12.0							
10 0.0		20 0.0	·						
		O U a U							
INCREMENT	13	20 12 0							
10 13.0		S.M. 124V							
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	STARTING FROB	EP	<u>-</u>			
 ,	BCPACE GENERAL	CHECK (PLANE STRAIN WITH Z-LCACS,	ELASTIC-PLASTIC-CRE	EP) 06/08/73		· · · · · · · · · · · · · · · · · · ·
	MAXIMUM TOTAL Maximum Elast	IFFNESS UPCATES PER INCREMENT = ITERATIONS PER INCREMENT = C ITERATIONS PER INCREMENT =	3 10 2			
	MAXIMUM RECLC	UCF FCR ELASTIC-PLASTIC SUM CODE = ICNS = 1 CUCTION FACTOR = 0.50000F 00	2			
	MAXIMUM SPECI	IED ERRCR NORM = 0.10000E-04 END OF INCREMENT TO EVALUATE SLOPE	= 0.100CGE GG			
	PLANE-STRAIN	PCBLEM				
	NO. OF MATERIA DEFAULT THICK	LS = 1 ESS = C.100C0E 01				
	FABRICATION TO	MPERATURE = 0.10000E 01				
	MATERIAL NO.	1 TEMPERATURE DEPENDENT PROPERTIE	: S			
	TEMPERATURE	THERMAL STRAIN				
	0.10C0E 01 0.2000E 01	0.0 0.3000E 00	- · · · · · · · · · · · · · · · · · · ·			
	C.3000E C1	0.80CGE 00				
	C.4000E C1	0.1050F 01				
	0.4500E C1	0.15GGE 01				<u> </u>
.º_	G.5000E C1	0.18005 01				<u></u>
<u>-</u>	C.6000E 01	0.23C0E 01		•		-1726
=-	C.8000E 01	C.2300E 01 0.1000E 01		- 	· · · · · · · · · · · · · · · · · · ·	
	G.9000E 01	0.5000€ 00				10
	0.1000E C2	0.1150F 01				
	C.12CCE C2	0.2050E 01				
	0.1300E 02	0.2500F 01				~ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
	C,1400F 02	0.28CCE 01		-		
	C.150CE 02	0.5162E 01				
	TEMPERATURE	ELASTIC MOD.				
	0,1000E 01 0,2000E 01	0.1000F 01 0.2000F 01				
	C.3000E C1	0.2500E 01				
	C.40CCE G1	0.30C0E 01				
	C.5000F 01	0.35COF 01				
	C.5400E 01	0.1000E 01				
	C.60CCE 01	0.4CCOE 01				
	C.7000E 01	C.20COE 01				
	0.9000E 01	0.1250E 01 0.1250E 01				
	O.1000E 02	0.20006 01				
	C.12CCF 02	0.3875E G1				
	C.1300F C2	0.4500E 01				
	C.1400E 02	0.5250E C1				
	C.1500E_Q2_	0.30CCE 01				
	TEMPERATURE	POISSONS RATIO				
	0.0	0.30008 00				

MATERIAL NO.	1.PLASTICITY TYPE 1.KINEMATIC CODE C
MATERIAL NO.	1. TEMPERATURE = 0.0
PARAMETER	1007DODIE CIDECC
0.C	ISCTROPIC_STRESS 0.200CDE 01
0.30000F C1	0.200CCE 01
0.9000CF C1	0.350CCE 01
PARAMETER	KINEMATIC SHAPE
0.0	0.0
C.1000CE 01	0.100COE 01
0.3000CF 01	0.20CCOF 01
C-SCOOCE OI	0.350COE 01
TEMPERATURE =	C.O
PARAMETER	
A A	ISCTROPIC STRESS 0.20CCOE 01
C.3000CE OL	0.20CCOE 01 0.20CCOE 01
0.500CCE 01	0.35CCCF 01
PARAMETER	KINEFATIC SHAPE
0.0	0.0
C-10000E C1	0.100CCF 01
0.3000CE C1	C.20CCOE 01
C.90000E 01	0.350CQE 01
با با با با سخندی	D5
7	17266
,-	6
MATERIAL NO.	1, CREEP TYPE 2
TIME	
0.0	COO
C.1000E 02	C-1000E 01
C.3000E 02	0-2000E G1
MATERIAL NO.	1. TEMPERATURE = 0.0
STRESS	
0.0	C-1000E 0I
0.3000E 01 C.1100E 02	
	U.700U: UI
MATERIAL NC.	
<u>STR</u> ESS (
0.0 0.3300E C1	0.1000E 01
G.33CGF C1 C.110GF C2	C. SOORE C.
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- 1 '

NC. CF LCA	C REFERENCE CURVE	S = 2						
	-							
NCCE C	ENCE CURVE NO.							·
30	2 C.1000GE C1							
40	2 C-10000F C1							
ii								
LCAD REFER	ENCE CURVE NO.	2						•
NODE C	CPPCNENT LCAC				······································			
		1						
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							<u> </u>	
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NO DE LOA	C INCREMENTS =	15						
INCREMENT	MAX. ITERATIONS	MECHANICAL CURVE	EACTORS	CREED TIME				
1	10	0.130COE 01	c.c	0.0				
2	10	0.28CCCE 01	0.0	0.50000E 01				
3	10	0.3550CE 01	<u>c.c</u>	0.0				
4	LO	0.580CCE 01	0.0	C.4COCOE O1				
	10 10	0.730G0E 01 0.730G0E 01	C.O	0.0				
7	10	0.60000E 01	0.0	0.0				
8	10	0.40CGCE 01	0.0	0.0			·	
9	10		0.0	0.10CCCE 02		•		
. 10	10	0.36500E 01	0.0	0.0				<u></u>
10 11 12 12 13	10	C.550CCE OL	_ <u>c.c</u>	0.10000E 02		<u>-</u>		
<u>f</u> 12 	10 10	0.655000 01	0.0	0.0				66-
14	10	0.75000E 01 0.88000E 01	0.0	0.0				
15	10	0.16287E 02	0.0	0.10000F 02				
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ELEMENT 1.0								
TEMP. Z-LCAO	C.20000E C1 0.20000E 0.0 C.0	.01 .						
ITEPATIVE I	RREP = 0.74557E 00	·						
TTERATIVE !	FRCR = 0.51221E 00			· · · · · · · · · · · · · · · · · · ·				
	FRCR = 0.74957E 00 FROR = 0.20911E-06							
	PRCR = 0.18C29E-06							
				<u> </u>				
								
	F	ND CF LC	L INCREME	NT 1				
						· · · · · · · · · · · · · · · · · · ·		
INCREMENT								
	LOAC CURVE FACTORS =	0.13COE C1,	0.0					
	INCREMENT = 0.0 ELEMENTS = 1. NO.	DI ACTIC ELEMEN	TC + 1					
	ENTS HAVE CHANGED EL			PLASTIC TO ELASTI	C DURING THIS	INCREMENT		
SPECIFIEC (AX. NO. STIFFNESS UP	CATES = 3, A	C. UPDATES PERFOR	MED = 0		- ·		
	AX. NO. ITERATIONS P				LAST UPDATE =	5		
SPECIFIED I	MAX. UNKALANCHE-FERLE	EKMCK = 0.1000)E-04. ACTUAL ERRO	16 = 0*18C3E-06		•		
• · · · · · ·								
.]	****** CUMULAT F	VE INTERNAL FORC	ES AND CISPLACEME	NTS ******				
57 ++ NODE ++	****** CUMULATI	******	**** CISPLACE	MENTS *****				
1-1	######## CUMULATI	******	ES AND DISPLACEME ***** DISPLACE U	NTS ****** MENTS ***** V				
NO. I.C.	******* CUMULATIU ******** FCRCES U V 0.2384166E-C6 0.	******** 9959990E 00	***** CISPLACE U 0-1721911E-06	MENTS ***** V 0-1299999E 01				
NO. I.C. 1 30 2 40	****** CUMULATI ******** FCRCES U V 0.2384186E-C6 0. -0.1976633F-06 C.	********* 9959590E 00 1000000E 01	***** CISPLACE U 0.1721911E-06 0.3848754E-06	MENTS ****** 0-1299999E 01 0-1299999E 01				
NO. I.C.	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
NODE *** NO I • C • 1 30 2 40 3 10	****** CUMULATI ******** FCRCES U V 0.2384186E-C6 0. -0.1976633F-06 C.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06	MENTS ****** 0.1299999E 01 0.1299999E 01				
NO 1 00 40 NODE ## NODE ## NO 1 0 C 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
NO. I.E. 1 30 2 40 3 10	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
NO 1 00 40 NODE ## NODE ## NO 1 0 C 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
NO 1 00 40 NODE ## NODE ## NO 1 0 C 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
** NODE ** NO. I.C. 1 30 2 40 3 10	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
** NODE ** NO. I.C. 1 30 2 40 3 10	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
** NODE ** NO. I.C. 1 30 2 40 3 10	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
** NODE ** NO. I.C. 1 30 2 40 3 10	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
** NODE ** NO. I.C. 1 30 2 40 3 10	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
** NODE ** NO. I.C. 1 30 2 40 3 10	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
NO. 1 00 44 NODE *** NO. 1 00 2 40 3 10	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
NO. 1 00 44 NODE *** NO. 1 00 2 40 3 10	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				
NO. 1 00 44 NODE *** NO. 1 00 2 40 3 10	******* CUMULATII ******** FCRCES U V 0.2384166E-C6 00.1976633F-06 C0.1146242E-06 -0.	**************************************	***** CISPLACE U 0.1721911E-06 0.3848754E-06 0.0	MENTS ****** 0.1299999E 01 0.1299999E 01				

		AL STRAINS ***		**** INCRE	**************************************	*******	* *****	***** CUMUL	ATIVE ******	
<u> </u>	INCREMENTA	L CUMULATIVE	XX	YY		хү	XX	YY		XY
		C 0.3000F 00	. 0.1000E	C1 -C.3000E	CO -0.3000E 0	0 0.1020E-	06 C.1000E	01 -0.3000E	00 -0.3000E 00	0.1020E-06
2 10	0.30005 (CC C.3000F 00	C.3500F	CO 0.3500E	00 -0.3000E 0	0 0:650CE	00 0.3500E	CO 0.3500E	00 -C.30CCE 00	0.65COE 00
								· · · · · · · · · · · · · · · · · · ·		
E4 EMEA.T		TIC NCAK ****			######################################			*********	**************************************	******
		IL CUPULATIV <u>e</u>		YY	ZZ	XY	XX	AA	22	XY
	0.0	<u>0.0</u>	G.O G.O	C. C	0.0	0.0	C.0	0.0	C+0 0-0	0.0
ELEMENT	EFFECTIVE CENTER	EFFECTIVE	******** ********	**** STRESS	******** CL CENTER ****	XY ###**################################	RESS CUANTITE * ******* XX	1ES ********	E22 ***********************************	XY ***********
							2 2222	0 01305	00 0 44175 0	. 0 15405-04
2 10	0.0	0.2000E 01 0.2000E 01	0.0	0.0	0.0	0.0			<u>-C8 -0.4677E-0</u> 01 -C.6877E-0	
1 - 16										500
ELEMENT	E-P SUM	INCREPENTAL	TCTAL	SURFACE	**** EFFECTI	VE_PLASTIC	STRAINS ***		TIVE CPEEP STE	
		TEMPERATURE T			INCREMENTAL 0.0	SUM INCR.	CUMULATIVE 0.0	INCREMENTAL 0.0	SUM INCR. CU	JPULATIYÊ
1 20 2 10		0.1000E 01			0.0	0.0	0.0	0.0	C.0	0.6
									- 	<u>. </u>
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	CUMINATIVE THERMAL ICARS	AND Z-LOADS FOR LOAD INCREM	FNT 2		
INCREMENT	2	TOPES CON LEGG INCREM	<u></u>		
ELEPENT I.C.	20 10				
	OE C1 C.3000QE 01				
Z-LCAD C.O	C.O				
	·				
ITERATIVE ERROR =					
ITERATIVE EPROR =					
ITERATIVE ERRCR =					
ITERATIVE ERRCR =			· — — — · · · · · · · · · · · · · · · ·		
ITERATIVE ERROR = ITERATIVE ERROR =					
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ITERATIVE EPRCR =					
ITERATIVE ERROR =				·	
TTEPATIVE EPRCR =					
ITERATIVE ERROR =				.,,	
ITERATIVE ERROR =					
ITERATIVE ERRCR = ITERATIVE ERRCR =					
ITERATIVE ERACR =					
ITERATIVE ERRCR =					
ITERATIVE ERRCR =					
	44441200 00				· .
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<u> </u>	····				
7	FNT CF 1 C	A C INCPEMENT	2		2,
			<u></u>		
INCREMENT	2				
	URVE FACTORS = 0.28COE 01.				
CREEP TIME INCREM		54.50 - a			
NO. ELASTIC ELEME	NTS = 0, NO. PLASTIC ELEM AVE CHANGED ELASTIC TO PLAST		TO ELASTIC DURING THIS I	NCOCHELT	
		NC. UPDATES PERFORMED =	1	NCKEMENT	
	. ITERATIONS PER UPCATE =	10. NO. ITERATIONS PERFORM		10	
	BALANCED-FORCE ERROR = C.10			••	

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nie ais ais.	ANNE PINEL ATTNE TATERNA FO	DOEC AND DECOLACEMENTS			
** NODE ** ***	***** COMPTAILAE TVIEKNYT EGI	**** **** DISPLACEMENTS ***			
NO. I.C. U	V	II V	rana ara		
<u> </u>					
	13335EF 64 0 1340E00F 01	C.2061823E-06 C.279999	9E C1		
1 30 -0.4	172325E-C6 0.1249595E 01			·	
	219438E-07 0.1249999 01	0.75736976-06 0.279999	9F 01		
2 40 0.7		0.7573697F-06 0.279999 0.0 0.0	98 01		

				STRAINS *** CUMULATIVE	**************************************	*** INCRE* *Y	'ENTAL ZZ		**************************************	**************************************	.+* CAWAT	_ATIVE ****** 22	YY
_115 €.		**. *	•	CG: SEPTITE		<u>'.'</u>					- ,		
1		20	0.5000E 00	C-800CE OC	C-7749E-06	-C.8345E-0	6 0.41	72E-06				00 -0-30CCE CO	
2		10	0.5000E CC	0*8000F 00	-0.1788E-C6	C.4768E-C	6 0.0		C.2384E-06	G.3500E CO	0.35005	00 -0.30COE 00	0.6500€ 00
				<u> </u>									
						— ——· ——-	· -						
					********	********	*****	******	PLASTIC S	TRAINS ****	*******	**********	*****
			***** PLASTI		*******	*** [VC6E*	ENTAL	*****	******	******	** CUMUL	ATIVE *****	********
NC.	<u>I.</u>	C. •	LNCPEMENTAL	CUMULATIVE	XX	- 44			_XY	XX	YY	22	XA
1		20	0.11256 01	0 <u>-1</u> 125E 01	0.5000F CO	-0-2500F 0	0 +0.25	ince oo	-0.2585E-07	0 50005 00	_0 25005	00 -0.2500E 00	_A 25055 A2
ż				0.1125E 01	0.1250E CO	C.1250E C	0 -0.25	00E 00	0.3750E 00	0.1250F 00		00 -0.2500E 00	
				-						_	DT1E300		3421396 90
													
			·				 .						
													
E: re	162		****	MORK ****	*******	*******	****	****	CREEP ST			********	
				CUMULATIVE	XX	YY INCKEP	ENTAL ZZ		XY	*********	YY CUMUL	LATIVE ************************************	**************************************
1		20	0.1125E 01	0,1125E 01	0.500CE 00	-C.2500E 0	0 -0.2	00E 00	-0.1644E-07	C.5000E 00	-0.2500E	00 -0.2500E 00	-0.1644E-07
2		10	0.1125E C1	C.1125E 01	C.1250€ 00	0.1250F 0	0 -0.25	500F 00	0.37505 00	0.1250E 00	0.1250E	00 -0.2500E 00	0.3750E 00
,													
					********	********	******	* CUMU	ATIVE STRES	S QUANTITIES	*******	********	*****
ELEM			EFFECTIVE	EFFECTIVE	*****	* STRESS	CENTER	*****	*****	*******	**** STE	RESS *******	******
VC.	I .	•	CENTER	STRESS	XX	YY	7.7		_XY	XX			XY
1	:	20	0.5000F CC	0.2500E D1	0.33338 00	-C.1667F 0	0 -0.16	67E 00 -	-0-1723F-07	0-2500E 01	-0-545AF-	-06 0.132CE-05	0.21325-04
2		ιō	0.5000E CC	0.2500E 01	0.8333E-01	C.8333E-0	1 -0.16	67E 00	0.2500F 00	C.1250E 01	0.1250E	01 -G-1284E-05	0.1250€ C1
-													
									. <u></u>				
EI C.M	Eac		E_D CIM TH	CREMENTAL	TOTAL C	TUDE ACE			DI 45775 577				
NO.	I .		LIK LOUP IN	CREMENTAL PERATURE TE	MPERATIRE VI	SURFACE SELD SIZE	THEF EN	TECTIVE	PLASTIC STRA	1 A T UE - **	PAR EFFEC	SUP INCR. CU	AINS ****
1		2Ç	0 2 C	.1000F 01 0	.3000E OL 0.	2000€ 01	0.5000	IF CO O	.500CF 00 0.	.5000E 00 0	-5000F 00	0.5000F 00	C.5000E 00
2		0	1 2 0	-1000F 01 0	.3CCOF 01 0.	2000E 01	0.5000	€ CO O	5000E 00 0	.5000E 00 0	.5000E 00	C-50CCE 00	0.5000E Q0
										····			
				- · · · - -—									• • • • •

	CONCLATING THERMAL LEADS	AND 1-15455 655 1545 14555454T	3	
TACREMENT	3	AND Z-LOACS FOR LOAD INCREMENT		
ELEMENT I.C.	20 10			
	000F 01 C.40000F 01			
Z-LCAD C.C	C • O	•		

	e = 0.81160E 00 e = 0.79893E_00			
	= 0.52446E 00		· · · · · · · · · · · · · · · · · · ·	
	* C.34C59E 00		· · · · · · · · · · · · · · · · · · ·	
	= 0.16222F 00		•	
	= 0.46823E-01			
	t = 0.16448E-01 t = 0.52084E-02		•	
	= 0.17755E-C2	· · · · · · · · · · · · · · · · · · ·		
I TERATIVE ERROR				
	= 0.28329E-04			
	= 0.2C166E-05	<u> </u>		
THERATIVE ERROR	e = 0.17412E-05			
	<u>,</u>			
	ENG CELC	ACINCREMENT 3		
		A D I WE CE DE CALL	·	
INCFEMENT	3			
MECHANICAL LOAD	CURVE FACTORS = 0.3550E 01,	0.0		7266
CREEP TIME INCO	EMENTS = 0.0 PLASTIC ELEM	ENTS = 2		
	HAVE CHANGED ELASTIC TO PLAST		LASTIC DURING THIS INCREMENT	
SPECIFIEC PAX.	NO. STIFFNESS UPDATES = 3.	NC. UPDATES PERFORMED = 1		
SPECIFIED MAX.	NO. ITERATIONS PER UPDATE =	10. NO. ITERATIONS PERFORMED S	INCE LAST UPDATE = 3	
SPECIFIED MAX.	UNBALANCED-FURCE ERRCR = 0.10	COE-O4, ACTUAL ERROR = 0.1741E	-05	
				
			· · · · · · · · · · · · · · · · · · ·	
	****** CUMBLATIVE INTERNAL FO	RCES AND CISPLACEMENTS ******	.	
	******* FCRCES *******	**** DISPLACEMENTS *****		
NO. I.C.	U V	<u> </u>		
	1.5960470E+C7 0.1499999E 01	0.1926832E-06		
	.4837949E-06 0.1499999E 01 .2636358E-06 -0.1499999E 01	-0.9204579E-06 0.3549999E 01 6.0 0.0	L	
	.6878261E-06 -0.1500000E 01	-0.6157362E-C6 C.C		
			non comment of the co	

		*** THERMAL				**************************************		STRAINS **** ********************************	AA kaaa Chwrf Vi kaaaxaaaaaa	<u> </u>	********* ********* XY
	1 20	0.2500E 0C	0.1050E 01	0.5960E-0 -0.2384E-0	C6 -0.2384E-	C6 0.2980E-C6 C6 0.8345E-06	0.5012E-07 0.7153E-06	0.1000E 01	1 -0.3000E 00	-C.300GE 00	0.1610E-06 0.6500£ 00
	· - ·										
	·	-	·								·
		***** PLAST INCREMENTAL		********** *********	**** INCRE	************* PENTAL ***** ZŽ	** PLASTIC S *********** XY	****	************** **** CUMULAT	ZZ IVE ******* ZZ	XX **********
 -		0.1375E C1 0.1375E C1	0.2500E 01 0.2500E 01			00 -0.2500E 00			-0.5000E 00		
											
	ELEMENT NO. 1.C.	EFFECTIVE CENTER	EFFECTIVE STRESS			********* CUM CENTER *****			7Y ****** 518ES		
9.1-20		0.1000E 01				CC -0.3333E 00			0.1004E-05 0.1500E 01		
	ELEMENT NO. 1.C. 1 20 2 10	0 2 0 0 2 0	C.1000F 01 0	MPERATURE	0.2000E 01	**** EFFECTIV INCREMENTAL S 0.5000E CO 0.5000E CO	UM INCR. CUM 0.1000E 01 0	MULATIVE IN	CREMENTAL SI		MULATIVE
			<u>-</u>						·		
			· · · ·								
			. ,								
								·			
. –		· · · · · · · · · · · · · · · · · · ·									

INCREMEN	τ	CUMULATI 4	VE THERMAL LOADS	AND Z-LCAES FOR LO	AC INCREMENT 4				
ELEMENT	I-C- 2	n	10						
TEMP.		E Q1 C.500				•			
Z-LGAD	0.0	C.0							
ITERATIV	E EPRCR =	0.SCC61E	00						
[TERATIV	E EPPCP =	0.902708	00						
ITERATIV	E ERRCA =	0.61C26E	00						
LIEPATIV	E ERRCR =	C.ECSBCE	00	_			•		
ITERATIV	E ERROR =	0.78C10E	00						
TTERATIV	E FRRCR =	0.58597E	00						
ITERATIV	E ERRCR =	0.307728	CO	•		•			
ITERATIV	E EPROR =	0.EC747E-	C1						
	E EPRCP =								
ITERATIV	E ERRCR =	0.27586E-	02						
1 TERATIV	E EPROP =	0.66289E-	C4						
ITERATIV									
I TERATIV	E EPROP =	0.E0714E-	05						
	·								
							<u>.</u>		
							•		
					_	·			
			END OF LO	AC INCREP	ENT 4				
				<u> </u>	-	·			
	_								D5
INCREMEN									<u></u>
			S = 0.5800E 01,	0.0					72
	ME INCREME								5-17266-2
- ML. ELPS	TIC ELEMEN		NO. PLASTIC ELEP						72
				IC. O ELEMENTS		IC DURING THIS	INCREMENT		
				NO. UPDATES PERFC					
				10, NO. ITEPATION		LAST UPDATE =			
SPECIFIE	L PPA. UNB	ALANCEU-FU	KCE EKMEN = 0.10	COE-04, ACTUAL ERR	OH = 0.60116-02				
	· · · · ·								
			·				•		
		.		 					
							,		
							···-		· · -
	****	*** COMOL	ATTUE INTERNAL EC	RCES AND DISPLACEM	FRITC ******				
. ** NODE	** ***	**** ECR	CES *******		EMENTS *****	_			
NC. I.			- V	U	¥				
				<u>~</u>					
1	3C 0-14	901165-05	0.1749996F 01	-0.5040766E+06	A. 5799959F AL				
			0.17499975 01	-0.1485283E-05					· ·
			-0.1749995E 01	C.O	0.0				
			-0.1749999E 01	-0.7957215E-C6					··
•	20 0.34	121371-00	-0.17433336 01	-0.17312135-00	0.0				
									
				•					

			*** THERMAL	STRAINS *** CUMULATIVE	********* XX	*****	EMENTAL ****	**************************************	*** *******	YY *****	LATIVE ****** 22	XY
	N									·		
	1 2	20 10	0.7500E CC 0.7500E CC	0.1800E 01. 0.1800E 01	0.2384E- -0.2980E-	C6 -0.6557F C6 -C.2980E	- <u>C6 0.2384E</u> - -C6 -0.3576F-	06 0.2066 06 0.3576	E-06 0.1000E E-06 0.3500E	01 -C.30CCE 00 0.3500F	00 -0.3000E	00 0.3676E-C6 00 0.6500E 00
	rı eüi		**** PLAST	16 160V atta	******	*****	**************************************	**** PLAS	TIC STRAINS		*********** LATIVE *****	
			INCREMENTAL		XX	_ YY		XY	××	YY	22	XY
_					A 1000F							
	2			0.5750E 01 0.5750E 01	C.2500E	00 0.2500E	00 -0.5000E	00 0.7500	F 00 C.5000	00 0.5000E	00 -C.1000E	01 -0.1202E-07 01 0.1500E 01
									EP STRAINS	******	********	*****
	ELEPE	ΝT	***** CREE	MORK ****			EMENTAL ****	********* **	*** ****** XX	U4U3 ****** YY	LATIVE ***** 22	*********** XY
	NC.	وتاوا	INCREMENTAL	CUMULATIVE	<u> xx</u>							
-	<u>1</u> . 2	2 <u>0</u> 10	0.1625E 01 0.1625E 01	0.2750E 01 0.2750E 01	0.5000E 0.1250E	CO -C.250CE CO G.1250E	00 -0.2500E 00 -0.2500E	00 0.5669 00 0.3750		E 01 -0.5000E E 00 0.2500E	00 -C.5000E 00 -0.5000E	00 -0.1077E-07 00 0.7500F 00
	ELEME			EFFECTIVE	******	**** STRES	S CENTER ***	******		******* ST	RESS ******	**************************************
	NU.	• E •	CENTER	STRESS	XX	<u> </u>	11	XY	XX	YY		^1
	2		0.1500F 01 C.1500F 01		0.1000E 0.2500E	C1 -0.500CE 00 0.2500E	00 -0.5000E 00 -0.5000E	00 -0.1408 00 0.7500	E-08 C.35001 E 00 G.17508			05 0.9896E-06 05 0.1750E 01
	ELEME	NT	F-P SUM IA	CREMENTAL	TCTAL	SURFACE VIELD SIZE	TNCREMENTAL		C STRAINS *** CUMULATIVE		CTIVE CREEP S SUM INCR.	
	1	20	0 2 (1,1000E 01 0	5000E 01	0.2000F 01	0.1000E 01	0.2000E	<u>01 0.20005 01</u>	0.5000E 0	0 C.10COF C1	C.1000E 01
	2	10		LIOCCE OL O.				0.20005	01 0.2000E 01	L 0.5000E 0	0 0.10COE C1	C.1000E CL
_												

INCREMENT "	CUMULATIVE THERMAL LOACS A	ANC Z-LCACS FOR LO	AC INCPEMENT 5	<u> </u>		
	20 10 OE_C1_C_60000F_01					
LTERATIVE EFRCR = LTERATIVE EFRCP =	0.85454E 00					
ITERATIVE ERROR = ITERATIVE ERROR = ITERATIVE ERROR =	0.63288E_00				,	
ITERATIVE ERROR = ITERATIVE ERROR = ITERATIVE ERROR =	0.603965-02					
ITERATIVE ERRCR = <u>ITERATIVE ERRCR =</u> ITERATIVE ERRCR =	0.21530E-04					
LTERATIVE ERRCR =	0.34204E-05					
	ENC CF LC	A C I A C R E M	E N T 5			
CREEP TIME INCREME	NTS = C. NO. PLASTIC ELEME	ENTS = 2				95-17266
SPECIFIET MAX. NO	AVE CHANGED ELASTIC TO PLAST! , STIFFNESS UPDATES = 3, . ITERATIONS PER UPDATE = BALANCED-FORCE ERROR = 0.100	NC. UPDATES PEPFO	RMEC = 1 IS PERFORMED SINCE	LAST UPDATE #	2	1-2
	**** CUMULATIVE INTERNAL FCF	CES AND CISPLACE	ENTS ****** EMENTS *****			
NC. I.C. U		U DISPUZ	V			
2 40 -0.8	172325E-06	-0.17823C9E-05 -0.1966750F-05	0.7299999E 01 0.7299999E 01 0.0	···		
3 1C 0.2 4 20 -0.1	150546E-05 -0.1999598E 01	-0.1236542F-05				
- · · · - · · · · · · · · · ·						<u> </u>

		т		STRAINS *** CUMULATIVE	*******	AA ****** INCE: **********	*********** EMENTAL ***** 55	*** ELASTIC S	TRAINS ** ******* XX	AA ++++* COMRF +*********	********** ATIVE ****** 25	XA ***********
	1 2	1C 50	0.5000F 00	0.2300F 01	0.1788E- 0.8345E-	-06 -0.9537E- -06 0.7153E-	-06 0.3576E-0 -06 -0.8345E-0	6 0.1464E-06 6 0.5960E-07	0.1000E 0.3500E	01 -0.30COE CO 0.35CCE	CO -C.30CCE CO	0.5140E-06 0.6500E 00
					*****			*** PLASTIC S	TOATNE N		*****	
				IC WORK **** CU#ULATIVE	****			XY XY			ATIVE ******	
				0.9500E 01 C.9500E 01				0 -0.1263E-06 0 0.7500F 00				
	-										- :	
			EFFECTIVE CENTER	EFFECTIVE STRESS			S CENTER **** ZZ	MULATIVE STRES	####### XX	1 <u>+5</u>	ESS ***********************************	XY
9.1-24	1	20	0.2000F 01	0-4000E 01	0.13336	01 -0.6667F	00 -0-6667F 0	00 -0.4351E-07 00 0.1000E 01	C_4000F	01 -0.3883E-	05	0.1582E-05 0.2000E 01 726
												·\\
	NO. I.	D. 20	CODE CODE T	NCREMENTAL EMPERATURE T G.10CGE 01 C.10CGE 01	O-6CCOE CL	0.2000E 01	INCREMENTAL C. LOCOE CI	VE PLASTIC STR SUM INCR. CUM C.3000F C1 O G.3000E G1 O	.3000E 01	INCREMENTAL 0.0	TIVE CREEP STR SUM INCR. CU 0.1000E C1 0.1000E C1	MULATIVE C.10COF_01
			·		_				<u> </u>	· — — — —		-·
											····	
									_ -.	_ -		. <u></u> ,
								··································		_ _		
				· · · — ·								

INCREMENT	·C			
515451 + 4 6				
ELEMENT I.D TEMP.	C. 70000E 01 C.7000E 01.			
	C.0 C.0			
ITERATIVE 8	ERRCR = 0.17C55E-05			
				
	•		•	
	<u> </u>			
	ENCGFLO			
	ENLEFE	LAUINCHEM	ENT 6	
INCREMENT	6 LOAD CURVE FACTORS = 0.7300E 01		<u> </u>	
MECHANICAL	LOAD CURVE FACTORS = 0.7300E 01	0.0		
NG. ELASTIC	INCREMENT = 0.0 ELEMENTS = 2, NO. PLASTIC ELEM	VENTS = 0		
O ELEM	MENTS HAVE CHANGED ELASTIC TO PLAST	TIC. 2 ELEMENTS	PLASTIC TO ELASTIC DURING THIS INCREMENT	
SPECIFIEC A	MAX. NO. STIFFNESS UPDATES = 3,	NC. UPDATES PERFC	RMEC = 0	
SPECIFIED #	MAX. NO. ITERATIONS PER UPDATE =	10. NO. ITERATION	S PERFORMED SINCE LAST UPDATE = 1	
SPECIFIED A	AX. UNBALANCED-FORCE EFRCR = 0.10	COE-04, ACTUAL ERR	DP = 0.17C6E-05	

	,			
** NODE **	****** CUMULATIVE INTERNAL FO			<u></u>
** NODE **	******* FCRCES *******		ENTS ****** EMENTS ***** Y	2-2005-2
** NODE ** NO. I.C.	******* FCRCES *******	**** DISPLAC	EMENTS *****	<u></u>
NO. 1.C.	+++++++ FCRCES +++++++ U V -0.13709C7E-C5 0.9999952E 0C	***** C1SPLAC U -0.7318404E-06	D.729999E 01	<u></u>
1 3c 2 40	-0.13709C7E-05 0.9999952E 0C 0.108609CE-05 0.9999962E 0C	+**** CISPLAC U -0.7318404E-06 -0.7711196E-06	D.729999E 01 0.729999E 01	<u></u>
1 3c 2 40 3 10	+****** FCRCES ******* U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3c 2 40	+****** FCRCES ******* U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** CISPLAC U -0.7318404E-06 -0.7711196E-06	######################################	<u></u>
1 3c 2 40 3 10	+****** FCRCES ******* U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+****** FCRCES ******* U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+****** FCRCES ******* U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+****** FCRCES ******* U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+******* FCRCES ******** U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+******* FCRCES ******** U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+******* FCRCES ******** U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+******* FCRCES ******** U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+******* FCRCES ******** U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+******* FCRCES ******** U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+******* FCRCES ******** U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+******* FCRCES ******** U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+******* FCRCES ******** U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3 <u>c</u> 2 40 3 1c	+******* FCRCES ******** U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>
1 3c 2 40 3 10	+****** FCRCES ******* U -0.13709C7E-C5 0.9999952E 0C 0.108609CE-O5 0.9999962E 0C -0.2082174E-O5 -0.9999943E 00	+**** C1SPLAC U -0.7318404F-06 -0.7711196E-06	######################################	<u></u>

	*** THERMAL	STRAINS ***	******	**** [NCRE	PENTAL ***	**** ELASTIC S'	*******	*** CUPUL	AT ! VE ******	*******
_VC• I•C•	INCREMENTAL	CUMULATIVE	XX	<u>YY</u>	Z <u>Z</u>	XY	XX	YY	11	XY
1 20	0.0	0.2300E 01.	0.0	0 50825-	2.0.20	-0.2987E-06	0.10005 01	-0.3000E	00 -C.300CE CC	0.2153F-C6
2 10		0.2300F 01	0.5978E-0	0.5982E-	66 0.0	-0.72586-07			CO -C.30CCE CO	
	-		. 		<u>-</u>					
						· · · · · · · · · · · · · · · · · · ·				
										
			*******	********	*******	**** PLASTIC S'	TRAINS ****	*******	*****	*******
		IC WORK ****	*******	**** INCRE	PENTAL ***	****	******	*** CUMUL	ATIVE ******	
NO. I.C.	INCREMENTAL	CUMULATIVE	XX.	<u> </u>		XY	XX	YY		YX
_ 1 20	0.0	C. 9500E al	0.0	0.0	0.0	0.0			01 -C.15CCE C1	
2 10	0.0	0.9500E 01	0.0	0.0	0.0	0.0	C.7500E CO	0.75COE	CO -C.15CCF C1	0.2250E 01
										
				<u> </u>				-,		
						CUPULATIVE STRES	S QUANTITIES	******	************ ESS ********	*******
ELEMENT NO. I.C.		EFFECTIVE STRESS	XX	AA. 214622	CENTER **	************* XY	XX	44 44 21 11 11 11 11 11 11 11 11 11 11 11 11	22	XY
1,00		211-633								
		0.2000E 01				00 -0.4351E-07			05 0.6898E-05	
2 10	0.2000E 01	0.2000E 01	0.33336 0	0 0.3333E	00 -0.00615	0C 0.1000E 01	C-1000E 01	G* Inche	01 -C-1832E-C5	C. TOCOE OI
	·	·				······································		<u>-</u>		
										
EI ENELT	F-D CUM I	MEDEMENTAL	TOTAL	CUREACE	EFFE	TINE OLICTIC CTO	ATLC	5555	**** COCCO CTO	ATMC SES
ELEMENT NO. I.C.	E-P SUM II		TCTAL PERATURE	SURFACE YIELD SIZE		TIVE PLASTIC STRA			TIVE CREEP STR	
NO. I.C. 1 20	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
NO. I.C. 1 20	-1 -1 (EMPERATURE TEM	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA	L SUM INCR. CUM	ULATIVE IN	CREMENTAL	SUM INCR. CU	MULATIVE C.10COE C1
NO. I.C. 1 20	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1
1 20 2 10	-1 -1 (EMPERATURE TEM 0.1000E 01 0	PERATURE 7000E 01	YIELD SIZE 0.2000E 01	INCREMENTA 0.0	L SUM INCR. CUMI 0.3000E 01 0.	ULATIVE IN	CREMENTAL 0.0	SUM INCR. CU C.10COE C1	MULATIVE C.10COE C1

THE THE THE THE THE PAL LOADS AND Z-LOADS FOR LOAD INCREMENT 7	
ELEMENT 1.C. 20 10 TEMP. C.54000F G1 C.54000F 01	
Z-LCAD C.O C.O	
ITERATIVE EFFCR = 0.42622E 00	
ITERATIVE ERRCR = 0.33171E 00	
ITERATIVE ERRCF = 0.17C19E 00	
TEPATIVE ERRCR = 0.12406E CO	
TERATIVE EFFCF = 0.35597E-01	
ITERATIVE ERRCR = 0.12619E-02	
I TERATIVE ERROR = 0.11159E-03 I TERATIVE ERROR = 0.12630E-05	
END OF LOAD INCREPENT 7	
· · · · · · · · · · · · · · · · · · ·	<u> </u>
INCREMENT 7 MECHANICAL LOAC CURVE FACTORS = 0.6000E 01, 0.0	7266
CREEP TIME INCREMENT = 0.0	
NC. ELASTIC ELEMENTS = 0, NO. PLASTIC ELEMENTS = 2 2 ELEMENTS HAVE CHANGED ELASTIC TO PLASTIC, 0 ELEMENTS PLASTIC TO ELASTIC DURING THIS INCREMENT	
SPECIFIEC MAX. NO. STIFFNESS UPDATES = 3, NC. UPDATES PERFCPMEC = 1	
SPECIFIED MAX. NO. ITERATIONS PER UPDATE * 10. NO. ITERATIONS PERFORMED SINCE LAST UPDATE = 4	
SPECIFIED MAX, UNBALANCED-FCPCE ERFCR = 0.10COE-04. ACTUAL FROR = 0.3431E-06	
****** CUMULATIVE INTERNAL FORCES AND DISPLACEMENTS *******	
** NODE **	
	
1 30 -0.4172326F-06 -0.3516674E-05 -0.6971468F-06 C.6C000C0F 01 2 40 0.4987565F-06 -0.2861023F-05 -0.5336210F+05 C.6C00000F 01	
2 40 0.4987565E-06 -0.2861023E-05 -0.5336210E-05 C.6000000E 01 3 1C -0.1361004E-06 0.4053116E-05 0.0 0.0	
4 20 0.5457656E-07 0.2324581F-C5 +0.6988167E-05 0.0	
	· · · · · · · · · · · · · · · · · · ·
	

				STRAINS **	* *****	************* ******* INCF YY	REMENTAL ++:	***** ELAST	IC STRAINS 4	A.A. ******* C.O.A.O.F. ************	************ 3V174 2.5	********* ********* XY
	. 1	20 10	-0.300CE CC -0.3000E CC	0.2003E 0 0.2000E 0	1 -0.1000E 1 -0.3500E	01 0.3000E	00 0.3000	00 -0.8922E- 00 -0.6500E		-05 -0.7808E+ -06 -0.4768E-		
								better DIACT	TE STRAINS	*******		
				IC MCRK ***	* *****	****** INCP	REMENTAL **	*********	** *****	****** CUMUL	ATIVE *****	*******
	NC • I	[.C.	INCREMENTAL	CUMULATIV	E XX	<u> </u>		XY	xx	YY	11	XY
			0.0	0.9500E 0 C.9500E 0	1 -0.2264E 1 -0.3509E	-05 0.11326 -C6 -C.35096	E-05 0.1132 E-06 0.7019	E-05 -0.8163E- E-06 -0.1053E-	-12 C.3000F -05 0.7500F	E 01 -0.1500E E 00 0.7500E	01 -0.1500E 01 00 -0.1500E C	1 -0.1383E-06 1 0.2250E 01
	ELEME NC. 1	20 20	0.2000E 01	EFFECTIVE STRESS 0.7867E-0 C.4907E-0	******* XX 5 0.13336	***** STRES	SS CENTER *: ZZ F 00 -0-6667	XY F 00 -0-4351F	** ****** XX -G7 -C_3338	TIES ******* ******** STR YY E-05 0.6298E- E-05 -0.1729E-	ESS ***********************************	XY 5 -0.5207E-06
	ELFME NO. I	AT - C+ - 20 - 10	CODE CODE T	0.16CCF 01	TEMPERATURE 0.5400F 01	SURFACE YIELD SIZE 0.2000F 01	F INCREMENT 1 0.2264E-	CTIVE PLASTIC AL SUM INCR. 05 0.3000F 0	CUMULATIVE 1 0.3000E 0	1 0.0	TIVE CPEEP ST SUM INCR. CI 0.1000E CI 0.1000E CI	MULATIVE C.1000F 01
	2	10	1 2 -	C.18005 01	0.54000 01					·		
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INCPEMENT	CUMULATIVE THERMAL LCACS AND Z-LCACS FOR LCAC INCREMENT 8
TEMP. C-80000	0 10 F <u>Q1 C.800</u> 00E <u>01</u> DE CC-C.600C0E 00
ITERATIVE ERRCR = ITERATIVE ERRCR =	0.55620E 00 0.78552E 00 0.61256E 00 0.26832E 00 0.10396E 00 0.29551E-01 0.51452E-02 0.27538E-02 0.27538E-02 0.636C4E-03 0.25289E-03 0.10876E-04 0.12559E-05
ITEPATIVE ERROR *	U-27306E-U6
· · · · · · · · · · · · · · · · · · ·	ENC OF L CAG INCREMENT 8
CREEP TIME INCREME NC. ELASTIC ELEMEN O ELEMENTS H. SPECIFIEC MAX. NO SPECIFIEC MAX. NO	B UPVE FACTORS = 0.4000E 01, 0.0 ENT = 0.0 ITS = 0. NO. PLASTIC ELEMENTS = 2 AVE CHANGED ELASTIC TO PLASTIC. O ELEMENTS PLASTIC TO ELASTIC DURING THIS INCREMENT STIFFNESS UPCATES = 3, NC. UPDATES PERFORMED = 1 ITERATIONS PEP UPCATE = 10, NC. ITERATIONS PEFFORMEC SINCE LAST UPDATE = 3 BALANCED-FORCE EPROR = 0.1000E-04, ACTUAL ERROR = 0.5951E-06
	**** CUMULATIVE INTERNAL FORCES AND DISPLACEMENTS ******* ***** FORCES ******* V U V
2 40 0.79 3 10 0.3	08023E-06 -0.3125035E 00

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					****					****	** ELAST		DATNC ±	****		****			
			*** THERMAL					INCREM	NTAL	****	******	***	*****	****	** CUM	ULATI		****	******
'	NC.		INCREMENTAL				<u> </u>						XX		YY		7.2		XY
	1 2	2 C	-0.1000F 01	0.1000E 01	-0.50	00E 00	0.1	500E 00	0.15	00E 00	G.2709E	-06	-G.5000E	_00_	0.1500	E 00	0.1500	E 00	-0.4059E-06 -0.3250E CO
	۲.	10	-0.10001 01		- 0.11	701 00					-0232300		- 0.17300						
										·			·						
-								·											
-	FLEM	ĒŇÍ	**** PLAST	C WCRK ****		****					** PLAST		RAINS +	****	******	** * * *	#######	****	********
_ ^			INCPEMENTAL				YY				XY		XX		YY		2.2		XY
	. 1	20	0.1563F 00	0.9656E 01	-0.50	00E 00	0.29	500E 00	0.25	00E 00	-0.92118	-07	C. 2500E	01 -	-0.1250	F 01	-0.1250	F 01	-0.2304E-06
	2	10	0.1563E CC	C.9656E 01	-C.12	5CE CC	-0.12	250E 00	0.25	00E 00	-0.3750	00	0.6250E	00	0.6250	E CO	-C.1250	F C1	0-1875E 01
-																			
		-														<u> </u>			
					****	****	*****	*****	*****	* CUP	ULATIVE S	TRESS	CUANTIT	IES	*****	****	******	****	******
	ELEMI			EFFECTIVE	**** XX	*****	** 51	RESS (ENTER	****	*****	**	*****		**** 5		****		******
	<u>\C.</u>	<u> </u>	CENTER	218522	**		YY				XY		XX		YY		27		XY
	. 1		0.1500F G1 0.1500E 01		0.10	00E C1	-0.50	00 B 00	0.50	00E 00	-0.1049E	-06	-0.6250E	00	0.8637	E-07	C.2201	E-05	-0.3903E-06
			0.13006 01		U.23				-0.50		u. 75006	. 00	+U+3123E	υ υ -	-0+3125	5 00	-0.3228	E-03	-0.31256 00
				_ 	·														
			·																
			E-P SUM LE				SURFAC				E PLASTIC				*** EFF	ECTIV	E CREEP	STRA	INS ****
	1_	20	0 2 (-2600E 01	0.8000E	01 0	.21255	01	0.5000	E CO_	0.3500E 0	1 0.	2500E 01	0.	0				0.1000E 01
	2	10	0 2 0	2.2600E D1	0.8000F	01 0	.21258	01	0.5000	E CO	0.3500F 0	1 0.	2500E 01	0.	. 0	C	.1000E	C1 (1000E 01
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INCREMENT	CLMULATIVE THERMAL LOADS	AND Z-LCAES FOR LO	AC INCREMENT 9	
ELEPENT 1.C				
	- 20 10 0.90000E 01 C.90000E 01			
	C.20000F GC-C.2000F 00			
************************	2000 - 2 224205 00			
	RRCR = 0.82428E 00 RRCR = 0.74455E 00		·	
	PPCP = 0.40413E 00		<u></u>	
	RRCF = 0.14128E-01		•	
ITERATIVE E	PPCP = 0.69163E-02		1	
	PRCP = 0.12068E-02			
	PRER = 0-29664E-03 PREP = 0-64185E-04		•	
	RRDR = 0.14244E-04			
	PRCP = 0.41961E-05			
	RRCR = 0.61726E-05			
······································				
	ENDOFL	CAC INCREM	ENT 9	
INCFEMENT	q			
	LGAC CURVE FACTORS = 0.1500E 01	. 0.0		
	INCREMENT = 0.1000E 02		•	D5
- NO. FLASTIC	ELEMENTS = 0, NO. PLASTIC ELE			
<u>ယ် ၂၂၂၀ ELEY</u> I	ENTS HAVE CHANGED ELASTIC TO PLAS	TIC. O ELEMENTS	PLASTIC TO ELASTIC DUPING THIS INCREMENT	1 17266
SPECIFIED W	AX. NO. STIFFNESS UPDATES = 3	, NC. UPDATES PERFO	RMEC = 1	
SPECIFIED M	AX. NO. ITERATIONS PER UPDATE = AX. UNBALANCED-FURCE ERROR = 0.1	10, NO. ITERATION	S PERFORMEC SINCE LAST UPDATE = 1	10
37 CC 1: 1 CO M	PAS GADALANCED-I GRCE ERRER - 4-1:	OUDE-OAT MCTURE EKK	0.01135-03	
	<u> </u>			
			•	
	****** CUMULATIVE INTERNAL F			
** NODE **	*******	##### DISPLAC	EMENTS *****	
NO. I.L.		<u> </u>	V	
1 30	-0.2205371E-C5 -0.6250015E 00	-0.3952121E-C5	C.1500CCCE 01	
2 40	0.1439869E-05 -0.6250042F 00	-0.2000027F 00	G.1500000F 01	
	0.25761C2E-05 0.625003CE 00	0.0	0.0	
3 1C		· · · · · · · · · · · · · · · · · · ·		
3 1C 4 20	-0.1810600E-05 0.6250029E CO	-C.200005CE 00		
		-C.200005CF 00		
		-C.200005CF 00		

-	ELEM	ENT	*** THERMAL	STRAINS ***	*****	*****	INCREME	NTAL ***	*****	*******	**** CLMULA	TIVE *****	********
	NC.	1.0.	INCREMENTAL	CUPULATIVE	XX	1	Y Y	72 .	XY	XX	YY	2.2	χ¥
	1	20	-0-5000E 00	0.5000£ 00	-0-5000F	00 0.	1500F 00	0_1500F	00 0.14566-0	7 -C-1000E 0	1 0.3000F 0	0.3000F	00 -0.3914F-06
	. 2	10	-0.5000F 00	0.5000E 00	-0.1750E	00 -0.	1750F 00	0.150CE	00 -0+3250E 0	0 -0.3500E 0	0 -0.35COE C	0.30CCE	CO -0.65COE 00
		- •	···	-									
	·-·								7.1	 			
-	:								***** PLASTIC	STRAINS ***	*******	*****	*******
			***** PLAST!		XX		INCREMI	ENTAL ***: <u>22_</u> _	**************************************	XX	**** ÇUKULA YY	71 (11AE ****	*********** XY
	1	20	0 44885 00	0 10125 02	~0.5000E	an n	2500E 00	0 25006	OC -0.5287E-0		1 =0.10005 (11 =0 1000£	01 -0 28336-06
	- 2	10	0.4688E CC	0.1012F 02	-C-1250E	CO -0.	1250E 00	C.250CE	00 -0.3750E C	G C.5000E O	0 0.500GE	O -C. LOCCE	01 0.1500E 01
					·						· ·		
				· · · · · · · · · · · · · · · · · · ·	*****	*****	*****	******	**** CREEP	STRAINS ***	********	******	
			***** CREEF INCREMENTAL		******* XX		INCREME	NTAL ***	**************************************	******** XX	**** CUMULA YY	TIVE *****	********* XY
											·		
	<u>}</u>	20 10	0.9375E 00 0.9375E 00	0.3688E 01 0.3688E 01	-0.1000E	C) -0.	,5000E 00 ,2500F C0	0.5000E	00 -0.4683E-0	0-2384E-0	<u>6 0-2384E∽0</u> 6 0-1073F-0	16 -0.4768E-1	06 -0.4791E-06 05 -0.5960E-07
-3: -32													
Ñ													
		-											
			EFFECTIVE	EFFECTIVE	*****	****	*******	*******	CUMULATIVE STR	ESS QUANTITIE	5 ********	******	********
	NC.			STRESS _	XX		318E33 (_ ZZ	XY	XX	YY 51K	:55 ***********************************	XY
			0 10005 01	0 10505 01									
	- <u>I</u>		0.1000E 01 C.1000E 01		0.1667E	00 0.	1667E 00	7 -0.3333E	00 -0.1402E-0	06 -0-1250E 0	1 -0.32456-0 0 -0.6250F 0	0.1969E-0	05 -0.3/63E-06 05 -0.6250E 00
	<u> </u>												
													
						-							
	ELEM	EŅĪ	41 MUZ 9-3	CREMENTAL	TCTAL	SURF		**** EFFEC	TIVE PLASTIC S		**** EFFECT	IVE CREEP ST	TRAINS ****
	NO.	1.0. 20							L SUM INCR. C O C.40COE C1			SUM INCR.	
,	2	10	0 2	-1000F 01 C	-9000E 01	0.22	CE OI	0.5000F G	0 0.4000E 01	0.2000F 01			0.1589E-05
												_	
									 -				

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INCREMENT 10
ELEMENT 1-C. 20 10 TEMP. 0.10000E 02 G.10000E 02 . Z-LCAD C.C C.O
ITERATIVE ERRCR = C.936C6E CO ITERATIVE ERRCR = 0.532CZE CO
ITERATIVE ERRCP = 0.64905E 00 ITERATIVE ERRCP = 0.10034E 00 ITERATIVE ERRCR = 0.81599E-01
TEPATIVE
TERATIVE ERRCR = 0.256345-01 TERATIVE ERRCP = 0.191245-01 TERATIVE ERRCR = 0.257475-06
17EPATIVE ERRCR = 0.11579E-06
9
END CFLCAD INCREMENT 10 26
INCREMENT 10 MECHANICAL LOAC CURVE FACTORS = 0.3650E C1, 0.0
CREEP TIME INCREMENT = 0.0 NO. FLASTIC ELEMENTS = 2, NO. PLASTIC ELEMENTS = 0 O ELEMENTS HAVE CHANGED ELASTIC TO PLASTIC, 2 ELEMENTS PLASTIC TO ELASTIC DURING THIS INCREMENT
SPECIFIED MAX. NO. STIFFNESS UPCATES = 3, NC. UPCATES PERFCRMEC = 1 SPECIFIED MAX. NO. ITERATIONS PER UPDATE = 10, NC. ITERATIONS PERFORMEC SINCE LAST UPCATE = 2 SPECIFIED MAX. UNBALANCED-FCPCE ERRCH = 0.1000E-04, ACTUAL ERROR = 0.1158E-06

NC. 1.E. U V
1 30

					CUMULA		XX		YY	22	•	XY		XX		YY		7.7		XY
	1 2	20 10	0.65	ooe oc	0.1150 0.1150	F 01.	0.1500	E CO	-0.4500E 0.5250F	00 -0.45 C0 -0.45	00E 00	0.3576E- 0.97505	00	.5000E	00 ~0 00 (0.1500E 0.1750F	00	-C.1500E -C.1500E	00	-0.3376E-0 0.3250E 0
			· · · · · · · · · · · · · · · · · · ·															<u> </u>	<u>-</u> -	
- -					IC WORK		*****		** INCE	********* EMENTAL		*****		*****		¢ ÇUMU		VE ***		******
	NC.	I • C •	<u>INC</u> FE	MENTAL	CUPULA	TIVE	XX		YY			ХҮ		XX		YY				XY
	1 2		0.C 0.O		0.1012	F 02	0.0		0.0 C.0	0.0		0.0		2000E 2.5000E	00	0.10C0E 0.50C0E	01 CO	-0.1000E -0.1000E	01 01	-0.2833E-0 0.1500E 0
			·····																	
			·							*******				UANTITI	t ES	*****	****	******	****	*****
	#1 5 44	EAT	FFFF	CTIVE	EFFECT			****	* STRES	S CENTER	****	******** XY	**	******** XX	*****	*** ST	PESS	***** ZZ	****	***************************
				***	CTOFC									.^^						~ ,
	NC.	1-0-	CEN		STRES		XX													
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9.1-34	NC.	1.C.	CENT O-10	00F 61	0.1000	E 01	0.6667	7E 00	-0.3333E	00 -0.33	3 <u>3E 00</u> 33E 00	-0.1402E- 0.5000E	-06 (00 (-1000E	01 -	0.2163E	-0 <u>7</u>	0.4120E -0.2540E	-05 -05	-0.5195E-0 0.50C0E 0
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XX ***********************************	77 	CT -0*2000E OC AA CO -0*20C0E CC CO -0*10C0E CC AA AA AA AA AA AA AA AA AA	** \$400E 0.5000E 0.5000E 0.5000E 0.5000E	XX 0° 0 0° 0 0° 0 0° 0 0° 0 0° 0 0° 0	22 0.0 0.0 0.0 23 4444 24 24 24 24 24 24 24 24 24 24 24 2	AA INCEE	D*D 2	CONDITION D'101SE 05 O'101SE 05 CONDITING CONDER ***	**** PLAST 1UCFEMENTAL 0.0 0.0	ELEMENT SO 20 1.0.
XX	72 	CT -0*2000E OC AA CO -0*20C0E CC CO -0*10C0E CC AA AA AA AA AA AA AA AA AA	C*3900E	### DF VZ1C CO	0.0 -0.1500E ****	AA INCEENT OF O	0*0 2 0*0 2 0*0 2 0*0 2 0*0 2	CONDITION D'101SE 05 O'101SE 05 CONDITING CONDER ***	***** CREE ***** CREE ***** DF W21 ***** CREE	ELEMENT SO 10

INCPEMENT	CUMULATIVE THERMAL LOADS	AND Z-LUAUS FUR LU	AC INCREMENT 12		·	
	0 10					
TEMP. 0.12000 2-LOAD 0.0	E G2 C.12000E O2			<u>-</u>		
£-E0#6 040			<i>'</i>			
TTERATIVE ERRCR =	0.93777E 00					
ITERATIVE ERROR =	0.0C830E 00					
ITEPATIVE ERROR =						
ITERATIVE ERROR =						
TTERATIVE ERRCR =					•	
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	END CF_LC	AC INCREM	ENT 12			
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INCREMENT	12					
	RVE FACTORS = 0.6550E C1.	0.0				
		0.0				
CREEP TIME INCREME NO. FLASTIC ELEMEN	NT = 0.0 its = 0, NO. PLASTIC ELEM	ENTS = 2				
CREEP TIME INCREME NO. ELASTIC ELEMEN	NT = 0.0 its = 0, NO. PLASTIC ELEM	ENTS = 2	PLASTIC TO ELASTIC	OURING THIS IS	NCPEMENT	
CREEP TIME INCREME NO. FLASTIC ELEMEN O ELEMENTS HA SPECIFIEC MAX. NO.	NT = 0.0 ITS = 0. NO. PLASTIC ELEM VE CHANGED ELASTIC TO PLAST STIFFNESS UPDATES = 3.	ENTS = 2 IC, 0 ELEMENTS NC_ UPDATES PERFO	RMET = 0			
CREEP TIME INCREMENTS HAS SPECIFIED MAX. NO. SPECIFIED MAX. NO. SPECIFIED MAX. NO.	NT = 0.0 iTS = 0. NO. PLASTIC ELEM VE CHANGED ELASTIC TO PLAST STIFFNESS UPDATES = 3, ITFPATIONS PER UPDATE =	ENTS = 2 IC, Q ELEMENTS NC. UPCATES PERFO	RMEC = 0 S PERECRMEC SINCE (
CREEP TIME INCREMENTS HAS SPECIFIED MAX. NO. SPECIFIED MAX. NO. SPECIFIED MAX. NO.	NT = 0.0 ITS = 0. NO. PLASTIC ELEM VE CHANGED ELASTIC TO PLAST STIFFNESS UPDATES = 3.	ENTS = 2 IC, Q ELEMENTS NC. UPCATES PERFO	RMEC = 0 S PERECRMEC SINCE (
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CREEP TIME INCREMENTS HAS SPECIFIED MAX. NO.	NT = 0.0 iTS = 0. NO. PLASTIC ELEM VE CHANGED ELASTIC TO PLAST STIFFNESS UPDATES = 3, ITFPATIONS PER UPDATE =	ENTS = 2 IC, Q ELEMENTS NC. UPCATES PERFO	RMEC = 0 S PERECRMEC SINCE (
CREEP TIME INCREME NO. FLASTIC FLEMEN O ELEMENTS HA SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE	NT = 0.0 ITS = 0, NO. PLASTIC ELEM VE CHANGED ELASTIC TO PLAST STIFFNESS UPDATES = 3, ITEPATIONS PER UPCATE = ALANCED-FCRCE EFFCR = 0.10	ENTS = 2 IC, O ELEMENTS NC. UPCATES PERFO 10, NC. ITERATION COE-04, ACTUAL ERR	RMEC = 0 S PERFCRMEC SINCE (CR = 0.5032E-05			
CREEP TIME INCREME NO. FLASTIC ELEMEN O ELEMENTS HA SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE	NT = 0.0 iTS = 0. NO. PLASTIC ELEM VE CHANGED ELASTIC TO PLAST STIFFNESS UPDATES = 3, ITFPATIONS PER UPDATE =	ENTS = 2 IC, Q ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION COE-04, ACTUAL ERR RCES AND DISPLACEM	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05			
CREEP TIME INCREME NO. FLASTIC ELEMEN O ELEMENTS HA SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE	NT = 0.0 ITS = 0, NO. PLASTIC ELEM VE CHANGED ELASTIC TO PLAST STIFFNESS UPDATES = 3, ITEPATIONS PER UPCATE = ALANCED+FCRCE EFFCR = 0.10 *** CUMULATIVE INTERNAL FC	ENTS = 2 IC, O ELEMENTS NC. UPCATES PERFO 10, NC. ITERATION COE-04, ACTUAL ERR	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05			
CREEP TIME INCREME NO. ELASTIC FLEMEN O ELEMENTS HA SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE **** **** *** *** *** *** *** *** *	NT = 0.0 ITS = 0.00. PLASTIC ELEMINATION OF THE PLASTIC TO PLASTI	ENTS = 2 IC, 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION 00E-04, ACTUAL ERR PCES AND DISPLACEM ***** DISPLAC	RMEC = 0 \$ PERFCRMEC SINCE (CR = 0.5032E-05 ENTS ************************************			
CREEP TIME INCREME NG. FLASTIC FLEMEN O ELEMENTS HA SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE *** *** *** *** *** *** ** **	NT = 0.0 ITS = 0.0 PLASTIC ELEMINES = 0.00. PLASTIC ELEMINES ELASTIC TO PLAST STIFFNESS UPDATES = 3. ITEPATIONS PER UPCATE = 0.10 **** CUMULATIVE INTERNAL FC ***** FORCES ******** V 28534E-05 0.1937495E C1	ENTS = 2 IC, O ELEMENTS NC. UPCATES PERFO 10, NO. ITERATION COE-04, ACTUAL ERR RCES AND DISPLACEM ***** CISPLAC U -C.4172507E-C6	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ******* EMENTS ****** V 0.6549959E 01			
CREEP TIME INCREME NO. ELASTIC ELEMEN O ELEMENTS HA SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE *** ** NOOE ** NC. I.G. U 1. 300.17 2 40 0.21	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINE CHANGED ELASTIC TO PLAST STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR STIFFNESS	ENTS = 2 IC, O ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION OOE-04, ACTUAL ERR RCES AND DISPLACEM ***** CISPLAC U -0.4172507E-C6 C.125169EE-C5	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ******* EMENTS ****** V 0.6549959E 01 0.654999E 01			
CREEP TIME INCREMENTS HAVE OF ELEMENTS HAVE SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE *** ** NODE ** NC. I.G. U 1 30 -0.17 2 40 0.21 3 10 -0.99	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINATION FOR THE PLASTIC TO PLASTIC STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR ERROR = V.10 **** FORCES ******** 28534E-05 0.1937495E C1 62575E-05 0.1937495E C1 C698CE-06 -0.1937495E C1	ENTS = 2 IC, O ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION OOE-04, ACTUAL ERR PCES AND DISPLACEM **** CISPLAC U -C.4172507E-C6 C.1251698E-C5 O.0	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ****** EMENTS ****** V 0.6549999E 01 0.6549999E 01			
CREEP TIME INCREME NO. ELASTIC ELEMEN O ELEMENTS HA SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE *** ** NODE ** NC. I.G. U 1 30 -0.17 2 40 0.21 3 10 -0.99	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINE CHANGED ELASTIC TO PLAST STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR STIFFNESS	ENTS = 2 IC, O ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION OOE-04, ACTUAL ERR RCES AND DISPLACEM ***** CISPLAC U -0.4172507E-C6 C.125169EE-C5	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ****** EMENTS ****** V 0.6549999E 01 0.6549999E 01			
CREEP TIME INCREMENTS HAVE OF ELEMENTS HAVE SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE *** ** NODE ** NC. I.G. U 1 30 -0.17 2 40 0.21 3 10 -0.99	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINATION FOR THE PLASTIC TO PLASTIC STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR ERROR = V.10 **** FORCES ******** 28534E-05 0.1937495E C1 62575E-05 0.1937495E C1 C698CE-06 -0.1937495E C1	ENTS = 2 IC, O ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION OOE-04, ACTUAL ERR PCES AND DISPLACEM **** CISPLAC U -C.4172507E-C6 C.1251698E-C5 O.0	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ****** EMENTS ****** V 0.6549999E 01 0.6549999E 01			
CREEP TIME INCREME NC. FLASTIC FLEMEN O ELEMENTS HA SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE *** ** NODE ** NC. I.G. U 1 300.17 2 40 0.21 3 10 -0.99	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINATION FOR THE PLASTIC TO PLASTIC STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR ERROR = V.10 **** FORCES ******** 28534E-05 0.1937495E C1 62575E-05 0.1937495E C1 C698CE-06 -0.1937495E C1	ENTS = 2 IC, O ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION OOE-04, ACTUAL ERR PCES AND DISPLACEM **** CISPLAC U -C.4172507E-C6 C.1251698E-C5 O.0	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ****** EMENTS ****** V 0.6549999E 01 0.6549999E 01			
CREEP TIME INCREMENTS HAVE SPECIFIED MAX. NO. SPECIFIED MAX. NO. SPECIFIED MAX. UNE *** NODE ** NC. I.C. U 1 30 -0.17 2 40 0.21 3 10 -0.99 4 20 0.55	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINATION FOR THE PLASTIC TO PLASTIC STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR ERROR = V.10 **** FORCES ******** 28534E-05 0.1937495E C1 62575E-05 0.1937495E C1 C698CE-06 -0.1937495E C1	ENTS = 2 IC, 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION 00E-04, ACTUAL ERR PCES AND DISPLACEM **** CISPLAC U -C.4172507E-C6 C.1251698E-C5 0.0 -0.6556511E-C6	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ************************************			
CREEP TIME INCREME NC. FLASTIC FLEMEN O ELEMENTS HA SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE *** ** NODE ** NC. I.G. U 1 300.17 2 40 0.21 3 10 -0.99	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINATION FOR THE PLASTIC TO PLASTIC STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR ERROR = V.10 **** FORCES ******** 28534E-05 0.1937495E C1 62575E-05 0.1937495E C1 C698CE-06 -0.1937495E C1	ENTS = 2 IC, O ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION OOE-04, ACTUAL ERR PCES AND DISPLACEM **** CISPLAC U -C.4172507E-C6 C.1251698E-C5 O.0	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ************************************			
CREEP TIME INCREMENDED FLASTIC ELEMENDO O ELEMENTS HAS SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINATION FOR THE PLASTIC TO PLASTIC STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR ERROR = V.10 **** FORCES ******** 28534E-05 0.1937495E C1 62575E-05 0.1937495E C1 C698CE-06 -0.1937495E C1	ENTS = 2 IC, 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION 00E-04, ACTUAL ERR PCES AND DISPLACEM **** CISPLAC U -C.4172507E-C6 C.1251698E-C5 0.0 -0.6556511E-C6	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ************************************			
CREEP TIME INCREME NC. ELASTIC ELEMEN O ELEMENTS HA SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE *** NOOE ** NC. I.C. U 1 30 -0.17 2 40 0.21 3 10 -0.99 4 20 0.55	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINATION FOR THE PLASTIC TO PLASTIC STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR ERROR = V.10 **** FORCES ******** 28534E-05 0.1937495E C1 62575E-05 0.1937495E C1 C698CE-06 -0.1937495E C1	ENTS = 2 IC, 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION 00E-04, ACTUAL ERR PCES AND DISPLACEM **** CISPLAC U -C.4172507E-C6 C.1251698E-C5 0.0 -0.6556511E-C6	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ************************************			
CREEP TIME INCREMENTS HAVE SPECIFIED MAX. NO. SPECIFIED MAX. NO. SPECIFIED MAX. UNE *** NODE ** NC. I.C. U 1 30 -0.17 2 40 0.21 3 10 -0.99 4 20 0.55	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINATION FOR TO PLASTIC TO PLASTIC STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR ERROR = V.10 **** FORCES ******** 28534E-05 0.1937495E C1 62575E-05 0.1937495E C1 C698CE-06 -0.1937495E C1	ENTS = 2 IC, 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION 00E-04, ACTUAL ERR PCES AND DISPLACEM **** CISPLAC U -C.4172507E-C6 C.1251698E-C5 0.0 -0.6556511E-C6	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ************************************			
CREEP TIME INCREMENTS HAVE OF ELEMENTS HAVE SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE **** ** NODE ** NC. I.G. U 1. 30 -0.17 2 40 0.21 3 10 -0.99 4 20 0.55	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINATION FOR TO PLASTIC TO PLASTIC STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR ERROR = V.10 **** FORCES ******** 28534E-05 0.1937495E C1 62575E-05 0.1937495E C1 C698CE-06 -0.1937495E C1	ENTS = 2 IC, 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION 00E-04, ACTUAL ERR PCES AND DISPLACEM **** CISPLAC U -C.4172507E-C6 C.1251698E-C5 0.0 -0.6556511E-C6	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ******* EMENTS ****** V 0.6549959E 01 0.6549995E 01 0.0			
CREEP TIME INCREMENDED FLASTIC ELEMENDO O ELEMENTS HAS SPECIFIEC MAX. NO. SPECIFIEC MAX. NO. SPECIFIED MAX. UNE	NT = 0.0 ITS = 0.0 ITS = 0.00. PLASTIC ELEMINATION FOR TO PLASTIC TO PLASTIC STIFFNESS UPDATES = 3. ITEPATIONS PER UPDATE = ALANCED+FORCE ERROR = 0.10 *** CUMULATIVE INTERNAL FOR ERROR = V.10 **** FORCES ******** 28534E-05 0.1937495E C1 62575E-05 0.1937495E C1 C698CE-06 -0.1937495E C1	ENTS = 2 IC, 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION 00E-04, ACTUAL ERR PCES AND DISPLACEM **** CISPLAC U -C.4172507E-C6 C.1251698E-C5 0.0 -0.6556511E-C6	RMEC = 0 S PERFCRMEC SINCE L CR = 0.5032E-05 ENTS ******* EMENTS ****** V 0.6549959E 01 0.6549995E 01 0.0			

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	AX			*****					*****		******							
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				*****	**** 241	912 21724	Id ***											_
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		3000E CO	********	0346*0		90-3894	L5*0 90	0.11926-0	42E-06	£8*0- 90	C*5384E-		10502°0		0*2200E	10	2	

CUMULATIVE THERMAL LOADS 1NGFEMENT 13	AND Z-LCACS FOR LCAC INCREMENT 13		
ELEMENT I.C. 20 10 TEMP. 0.13000E C2 C.13000E 02 Z-LCAC 0.20000F CC C.2C000F OC			
ITERATIVE ERROR = 0.52380E 00 ITERATIVE ERROP = 0.61836E 00 ITERATIVE ERROP = 0.58817E 00			
ITEPATIVE ERRCR = 0.59557E CO			
FND CF LC	TACINCREMENT 13		05-
MECHANICAL LOAD CURVE FACTORS = 0.7500E 01, CREEP TIME INCREMENT = 0.0 NO. FLASTIC ELEMENTS = 0, NO. PLASTIC ELEM	PENTS = 2		05-17266-2
	IC, O ELEMENTS PLASTIC TO ELASTIC DURI NC. UPDATES PERFCRMEC = 1 10, NO. ITERATIONS PERFORMEC SINCE LAST U COE-04, ACTUAL ERROR = 0.1236E-05		
** NODE **	PCES AND DISPLACEMENTS ****** ***** CISPLACEMENTS ******		
NC. 1.C. U V 1 3C	0.4548076E=C7		
3 10 0.1000672E-06 -0.2249993F 01 4 20 -0.5963975E-06 -0.2249993E 01	0.0 0.20000CCF 00 0.0		
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EL CHENT	ANA TUEDNA	STRAINS ***	******	*********	PENTAL *****	** FLASTIC S	TRAINS ###	**** CUMU	ATTUE BRANK	*********
		CUMULATIVE	XX	YY YOUR	7.7	XY	XX	YY	21	XY
<u>1</u> 20 2 10	3.4500E CC	0.2500E 01	-0.7153E+0	0.5364E- 06 -0.4172F-	06 -0.7153E-06 C6 -0.2980E-06	-0.3998E-07 -0.5960E-06	G-1000E 0	1 -0.3000E 0 0.3500E	00 -0.3000E	CO -0.1126E-07
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		IC WCRK ****			************* MENTAL *****		*** ZNIART: ******** *X	**** CUMUL	************ ATIVE ***** ZZ	*********** *********** XY
1 20		0.1400E 02 0.1400E 02	0.5000E	00 -0.2500E	00 -0.2500E 00 00 -0.2500E 00	0.3998E-07	C.3000E	1 -0.1500E	01 -C.1500E	01 -0-2125E-06 01 0-2250E C1
			····							
ELEMENT	EFFECTIVE	EFFECTIVE	*******	**************************************	********* CUP	ULATIVE STRES	S QUANTITIE	S *******	*********** ESS ******	*********
NE. I.C.		STRESS	XX	77	11	XY	XX	YY	11	XY
		0.4500E 01 0.4500E 01	0.1333E (01 -0.6667E 00 C.3333E	00 -0.6667E 00	0-0.9295E-07 0-1000E 01				05 -0.3899€-07 05 0.2250E 01
			0.1333E (01 -0.6667E 00 C.3333E	00 -0.6667E 00 00 -0.6667E 00	0 -0.9295E-07 0 0.1000E 01				
2 10	0.2000F 01	0.4500£ 01	0.33336	00 C.3333E	00 -0.6667E 00	0 d.1000E 01	0.2250E	1 0.2250E	01 -0.1525E-	C5 0.2250E 01
2 10	6-P SUM INCODE CODE TE	0.4500E 01	O.3333E	SURFACE	**** EFFECTIVE INCREMENTAL S	G.1000E 01 (E PLASTIC STRUM INCR. CUP	0.2250E (**** EFFEC	TIVE CREEP S	CS 0.2250E Q1 TRAINS **** CUMLLATIVE
2 10 ELEMENT NO. I.C. 1 20	E-P SUM INCODE CODE TE	CPEMENTAL EMPERATURE TE	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	GE PLASTIC STR	0.2250E (**** EFFEC	TIVE CREEP S SUM INCR. 0.3000E C1	C5 0.2250E Q1 TRAINS **** CUMLLATIVE 0.1000E Q1
ELEMENT NO. I.C.	E-P SUM INCODE CODE TE	0.4500E 01	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	G.1000E 01 (E PLASTIC STRUM INCR. CUP	0.2250E (**** EFFEC	TIVE CREEP S SUM INCR. 0.3000E C1	CS 0.2250E Q1 TRAINS **** CUMLLATIVE
2 10 ELEMENT NO. I.C. 1 20	E-P SUM INCODE CODE TE	CPEMENTAL EMPERATURE TE	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	GE PLASTIC STR	0.2250E (**** EFFEC	TIVE CREEP S SUM INCR. 0.3000E C1	C5 0.2250E Q1 TRAINS **** CUMLLATIVE 0.1000E Q1
2 10 ELEMENT NO. I.C. 1 20	E-P SUM INCODE CODE TE	CPEMENTAL EMPERATURE TE	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	GE PLASTIC STR	0.2250E (**** EFFEC	TIVE CREEP S SUM INCR. 0.3000E C1	C5 0.2250E Q1 TRAINS **** CUMLLATIVE 0.1000E Q1
2 10 ELEMENT NO. I.C. 1 20	E-P SUM INCODE CODE TE	CPEMENTAL EMPERATURE TE	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	GE PLASTIC STR	0.2250E (**** EFFEC	TIVE CREEP S SUM INCR. 0.3000E C1	C5 0.2250E Q1 TRAINS **** CUMLLATIVE 0.1000E Q1
2 10 ELEMENT NO. I.C. 1 20	E-P SUM INCODE CODE TE	CPEMENTAL EMPERATURE TE	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	GE PLASTIC STR	0.2250E (**** EFFEC	TIVE CREEP S SUM INCR. 0.3000E C1	C5 0.2250E Q1 TRAINS **** CUMLLATIVE 0.1000E Q1
2 10 ELEMENT NO. I.C. 1 20	E-P SUM INCODE CODE TE	CPEMENTAL EMPERATURE TE	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	GE PLASTIC STR	0.2250E (**** EFFEC	TIVE CREEP S SUM INCR. 0.3000E C1	C5 0.2250E Q1 TRAINS **** CUMLLATIVE 0.1000E Q1
2 10 ELEMENT NO. I.C. 1 20	E-P SUM INCODE CODE TE	CPEMENTAL EMPERATURE TE	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	GE PLASTIC STR	0.2250E (**** EFFEC	TIVE CREEP S SUM INCR. 0.3000E C1	C5 0.2250E Q1 TRAINS **** CUMLLATIVE 0.1000E Q1
2 10 ELEMENT NO. I.C. 1 20	E-P SUM INCODE CODE TE	CPEMENTAL EMPERATURE TE	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	GE PLASTIC STR	0.2250E (**** EFFEC	TIVE CREEP S SUM INCR. 0.3000E C1	C5 0.2250E Q1 TRAINS **** CUMLLATIVE 0.1000E Q1
2 10 ELEMENT NO. I.C. 1 20	E-P SUM INCODE CODE TE	CPEMENTAL EMPERATURE TE	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	GE PLASTIC STR	0.2250E (**** EFFEC	TIVE CREEP S SUM INCR. 0.3000E C1	C5 0.2250E Q1 TRAINS **** CUMLLATIVE 0.1000E Q1
2 10 ELEMENT NO. I.C. 1 20	E-P SUM INCODE CODE TE	CPEMENTAL EMPERATURE TE	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	GE PLASTIC STR	0.2250E (**** EFFEC	TIVE CREEP S SUM INCR. 0.3000E C1	C5 0.2250E Q1 TRAINS **** CUMLLATIVE 0.1000E Q1
2 10 ELEMENT NO. I.C. 1 20	E-P SUM INCODE CODE TE	CPEMENTAL EMPERATURE TE	TCTAL PPERATURE	SURFACE YIELD SIZE C.25COE 01	#### EFFECTIVE INCREMENTAL SOLUTION OF THE PROPERTY OF THE PRO	GE PLASTIC STR	0.2250E (***** EFFEC NCREMENTAL 0.0	TIVE CREEP S SUM INCR. 0.3000E C1	C5 0.2250E Q1 TRAINS **** CUMLLATIVE 0.1000E Q1

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ELEMENT 1.C.	~~	<u> </u>				
TEMP.	. 2G 0.14000E 02 <u>0.1400</u>	10 0F 02				
	0.0 C.0	<u> </u>				
	·					
	RRCF = 0.726496 0					
	PRCR = 0.81608E O PRCR = 0.92921E O					
	RRCR = 0.58297E 0					
	PRCP = 0.25604E 0					
	RRCR = 0.39645E-0			<u></u>		
	RRCP = 0.72418E-0					
	RRCR = 0.127826-0 PROR = 0.227496-0					
	RRCR = 0.409276-0					
	RRCR = 0.10559E-0					
ITERATIVE E	RRCP = 10.93568E+0	5			· · · · · · · · · · · · · · · · · · ·	
						
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		END CF L C	ACINCREM	ENT 14		
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INCREMENT	14					
TROPIC COLOR			0.0		`	
MECHANICAL	LOAD CURVE FACTORS	= 0.8800E 01.	4.0			
CREEP TIME	LOAD CURVE FACTORS INCREMENT = 0.0					
CREEP TIME	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0.	NO. PLASTIC ELEME	NTS = 2			
CREEP TIME NC. FLASTIC O ELEM	LOAD CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ENTS HAVE CHANGED	NO. PLASTIC ELEME ELASTIC TO PLASTI	NTS = 2 C. 0 ELEMENTS	PLASTIC TO ELASTIC DI	URING THIS INCREMENT	
CREEP TIME NC. FLASTIC O FLEM SPECIFIEC M	LOAD CURVE FACTORS INCREMENT = 0.0 ELFMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS	NO. PLASTIC ELEME ELASTIC TO PLASTI UPDATES = 3,	NTS = 2 C+ 0 ELEMENTS NC+ UPDATES PERFO	RMEC = 1		
CREEP TIME NC. ELASTIC O ELEM SPECIFIED M SPECIFIED M	LOAD CURVE FACTORS INCREMENT = 0.0 ELFMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE =	NTS = 2 C. O ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION	RMEC = 1 S PERFORMEC SINCE LAS		
CREEP TIME NC. ELASTIC O ELEM SPECIFIED M SPECIFIED M	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ELTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITEFATIONS	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE =	NTS = 2 C. O ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION	RMEC = 1 S PERFORMEC SINCE LAS		
CREEP TIME NC. ELASTIC O ELEM SPECIFIED M SPECIFIED M	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ELTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITEFATIONS	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE =	NTS = 2 C. O ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION	RMEC = 1 S PERFORMEC SINCE LAS		
CREEP TIME NC. FLASTIC O FLEM SPECIFIED M SPECIFIED M	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ELTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITEFATIONS	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100	NTS = 2 C. 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION 0E-04, ACTUAL ERF	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05		
CREEP TIME NC. ELASTIC O ELEM SPECIFIED M SPECIFIED M	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ELTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITEFATIONS	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100	NTS = 2 C. 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION 0E-04, ACTUAL ERF	RMEC = 1 S PERFORMEC SINCE LAS		
CREEP TIME NC. FLASTIC O FLEM SPECIFIED M SPECIFIED M	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ELTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITEFATIONS	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100	NTS = 2 C. 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION 0E-04, ACTUAL ERF	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05	T UPDATE = 2	
CREEP TIME NC. FLASTIC O FLEM SPECIFIED M SPECIFIED M	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100	NTS = 2 C, 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION 0E-04, ACTUAL ERF	RMEC = 1 S PERFORMEC SINCE LAS OF = 0.9357E-05	T UPDATE = 2	
CREEP TIME NC. ELASTIC O ELEM SPECIFIEC M SPECIFIED M SPECIFIED M	LOAC CURVE FACTORS INCREMENT = 0.0 ELFMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100	NTS = 2 C, 0 ELEMENTS NC. UPDATES PERFO 10, NC. ITERATION 0E-04, ACTUAL ERF	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05 ENTS *******	T UPDATE = 2	
CREEP TIME AC. FLASTIC O ELEM SPECIFIED M SPECIFIED M SPECIFIED M	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100	NTS = 2 C, 0 ELEMENTS NC. UPDATES PERFO 10, NC. ITERATION 0E-04, ACTUAL ERF	RMEC = 1 S PERFORMEC SINCE LAS OF = 0.9357E-05	T UPDATE = 2	
CREEP TIME NC. ELASTIC O ELEM SPECIFIEC M SPECIFIED M SPECIFIED M	LOAC CURVE FACTORS INCREMENT = 0.0 ELFMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100 TIVE INTERNAL FOR ES ********	NTS = 2 C, 0 ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION DE-04, ACTUAL ERF CES AND CISPLACEM ***** DISPLACEM	RMEC = 1 S PERFORMEC SINCE LAS OF = 0.9357E-05 ENTS ****** EMENTS ****** V	T UPDATE = 2	
** NODE ** NO. I.C.	LOAC CURVE FACTORS INCREMENT = 0.0 ELFMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR ****** CUMULA ******** FORC U -0.4112720E-05	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100 TIVE INTERNAL FOR ES ******** V 0.2624991E 01	NTS = 2 C, O ELEMENTS NC. UPDATES PERFO 10, NO. ITERATION DE-04, ACTUAL FRE CES AND DISPLACEM ***** DISPLACEM U 0.5436887E-C6	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05 ENTS ****** EMENTS ****** V C.8799999E C1	T UPDATE = 2	
** NODE ** NO. 1.C.	LOAC CURVE FACTORS INCREMENT = 0.0 ELFMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR ******* CUMULA ******** FORC U -0.4112720E-05 0.4693330E-05	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100 TIVE INTERNAL FCR ES ******** V 0.2624991E 01 0.2624992E 01	CES AND CISPLACEM ***** DISPLACEM 0.5436897E-C6 0.1668930F-05	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05 ENTS ****** EMENTS ***** V C.8799999E C1 C.8799999E O1	T UPDATE = 2	
** NODE ** NO. J.C. 1 30 2 40 3 FLEP	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR ******* CUMULA ******** FORC -0.4112720E-05 -0.1698966E-05 -0.1698966E-05	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100 TIVE INTERNAL FCE ES ************************************	CES AND CISPLACEN ***** DISPLACE 0.5436897E-C6 0.1668930F-05 0.0	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05 ENTS ****** EMENTS ***** V C.8799999E C1 C.8799999E O1 0.0	T UPDATE = 2	
** NODE ** NO. 1.C.	LOAC CURVE FACTORS INCREMENT = 0.0 ELFMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR ******* CUMULA ******** FORC U -0.4112720E-05 0.4693330E-05	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100 TIVE INTERNAL FCE ES ************************************	CES AND CISPLACEM ***** DISPLACEM 0.5436897E-C6 0.1668930F-05	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05 ENTS ****** EMENTS ***** V C.8799999E C1 C.8799999E O1 0.0	T UPDATE = 2	
** NODE ** NO. 1.C. 1 30 2 40 3 ELEM	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR ******* CUMULA ******** FORC -0.4112720E-05 -0.1698966E-05 -0.1698966E-05	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100 TIVE INTERNAL FCE ES ************************************	CES AND CISPLACEN ***** DISPLACE 0.5436897E-C6 0.1668930F-05 0.0	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05 ENTS ****** EMENTS ***** V C.8799999E C1 C.8799999E O1 0.0	T UPDATE = 2	
** NODE ** NO. 1.C. 1 30 2 40 3 ELEM	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR ******* CUMULA ******** FORC -0.4112720E-05 -0.1698966E-05 -0.1698966E-05	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100 TIVE INTERNAL FCE ES ************************************	CES AND CISPLACEN ***** DISPLACE 0.5436897E-C6 0.1668930F-05 0.0	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05 ENTS ****** EMENTS ***** V C.8799999E C1 C.8799999E O1 0.0	T UPDATE = 2	
** NODE ** NO. 1.C. 1 30 2 40 3 ELEM	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR ******* CUMULA ******** FORC -0.4112720E-05 -0.1698966E-05 -0.1698966E-05	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100 TIVE INTERNAL FCE ES ************************************	CES AND CISPLACEN ***** DISPLACE 0.5436897E-C6 0.1668930F-05 0.0	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05 ENTS ****** EMENTS ***** V C.8799999E C1 C.8799999E O1 0.0	T UPDATE = 2	
** NODE ** NO. J.C. 1 30 2 40 3 FLEP	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR ******* CUMULA ******** FORC U -0.4112720E-05 -0.1698966E-05 -0.1698966E-05	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100 TIVE INTERNAL FCE ES ************************************	CES AND CISPLACEN ***** DISPLACE 0.5436897E-C6 0.1668930F-05 0.0	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05 ENTS ****** EMENTS ***** V C.8799999E C1 C.8799999E O1 0.0	T UPDATE = 2	
** NODE ** NO. 1.C. 1 30 2 40 3 ELEFIED TO THE TO	LOAC CURVE FACTORS INCREMENT = 0.0 ELEMENTS = 0, ENTS HAVE CHANGED AX. NO. STIFFNESS AX. NO. ITERATIONS AX. UNBALANCED-FOR ******* CUMULA ******** FORC U -0.4112720E-05 -0.1698966E-05 -0.1698966E-05	NO. PLASTIC ELEME ELASTIC TO PLASTI UPCATES = 3, PER UPCATE = CE ERRCR = C.100 TIVE INTERNAL FCE ES ************************************	CES AND CISPLACEN ***** DISPLACE 0.5436897E-C6 0.1668930F-05 0.0	RMEC = 1 S PERFORMEC SINCE LAS OR = 0.9357E-05 ENTS ****** EMENTS ***** V C.8799999E C1 C.8799999E O1 0.0	T UPDATE = 2	

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INCREMENT	CUMULATIVE THERMAL LEADS AND Z-LEADS FOR LEAD INCREMENT 15	<u> </u>
ELEMENT I.C.	20 10	
	COOE 02 0.15000E 02	···· - -
Z-LCAD 0.0	c-0	
TERATIVE FRACE	= 0.54681E CO	· -
ITERATIVE ERRCR		
	= 0.70383E 00	
	= 0.49096E-01	
ITERATIVE ERRCR		
	= 0.900578 00	
ITERATIVE ERRCR		
ITERATIVE ERROR		
ITERATIVE ERRCF		
ITERATIVE ERRCR		
ITERATIVE ERRCP		
ITERATIVE ERROR		
ITERATIVE ERRCP		
ITERATIVE ERRCR	⇒ 0.26775E 00	
ITERATIVE ERRCR	= 0.673886-01	
ITERATIVE ERROR	# 0.46999E-01	
ITERATIVE ERRCR	= 0.2C906F-01	
TTERATIVE ERROR	= 0.10267E-01	
ITERATIVE ERRCP	= 0.48489E-02	
ITERATIVE ERRCP	= 0.24238E-02	
ITERATIVE ERRCP	= 0.37C40E-03 .	8
TTERATIVE ERRCR	= 0.18710E-03	<u>-</u>
. ITERATIVE ERROR		. 72
ITERATIVE ERROR		ట్
' ITERATIVE ERRCR		No.
ITERATIVE ERROR		
ITERATIVE ERRCP	= 0.59181E+05	
	END CF LCAC INCREMENT 15	
INCOCHENT	16	
INCREMENT	15 CURVE FACTORS = C.1629E 02, C.0	
	FMFNT = 0.1000F 02	
NC. ELASTIC ELEM		
	HAVE CHANGED ELASTIC TO PLASTIC. O ELEMENTS PLASTIC TO ELASTIC DURING THIS INCREMENT	
SPECIFIEC MAX. M	NO. STIFFNESS UPCATES = 3, NC. UPCATES PERFCRMEC = 2	
SPECIFIED MAX. N	NO. ITERATIONS PER UPDATE = 10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE = 7	
SPECIFIED MAX. L	UNBALANCEC-FCRCE ERRCP = C.10COE-04, ACTUAL ERROR = 0.5918F-05	
	***** CUMULATIVE INTERNAL FORCES AND DISPLACEMENTS *******	
** NODE ** **	****** FCRCES ******* ***** DISPLACEMENTS *****	
NO. 1.E. U	Ų V	
	.26822C9E-C5 0.2999987E C1 0.8409859E-06 0.1628749E 02	
	.3983378E-C5 0.2999991E 01 0.1060135E-04 0.1628749E 02	
	.2552869F-C5 -0.2999989E 01	
4 20 -0.		

	*** THERMAL INCREMENTAL		******	**************************************	######################################	***** FLASTIC ************************************	***********		**************************************	
										XY
1 20 2 10	0.2363F C1 0.2363F C1	0.5162E 01	C.3500E	00 0.3500	DE 00 -0.3000E	00 0.1492E-0	C.7000E	C1 -0.60C0E C0 0.70CCE	CO -C.60CCE CC	0.1300E C1
		-								
		·								
			******	********	*****	***** PLASTIC	STRAINS **	********	*******	*****
	***** PLASTI		******	***** INC	FEMENTAL ***	********	******	***** CUPUL	ATIVE *****	********
NUa lata	INCREMENTAL	COPULATIVE		YY		XY	XX	YY	11	XY
	0.5625E 01 0.5625E 01		0.1000E 0.2500E	01 -0.5000 00 0.2500	00 -0.5000E	00 -C.1347E-C	5 C.5000E 0 0.1250E	01 -0.2500E 01 0.1250E	01 -0.2500E 01 C1 -C.25CCE C1	-0.1846E-05 0.3750E C1
: <u></u>					<u> </u>					
			******	********	******	**** _ CREEP	STRAINS *		******	******
	***** CPEE! INCREMENTAL			***** [N{ YY	REMENTAL ****	************* XY	******** XX	YY CUMUL	ATTVE *******	********* XY
7.50							*****			
1 20										
l. 20 2 10	0.1758E C2 0.1758E C2	0.2339E 02 0.2339E 02	0.3125E C.7812E	C1 -C.1562 C0 0.7812	E 01 -0.1562E E 00 -0.1562E	01 -C.2273E-C 01 0.2344E C	5 0.4125E 1 0.1031E	01 -0.2062E 01 0.1031E	01 -0.2062E 01 01 -C.2062E 01	-0.2994E-05 -0.3094E 01
1 2C 2 10	0.1758E C2 0.1758E C2	0.2339F 02 0.2339F 02	0.3125E C.7812E	C1 -C.1562 C0 0.7812	E 01 -0.1562E E 00 -0.1562E	01 -C.2273E-C 01 0.2344E C	5 0.4125E 1 0.1031E	01 -0.2062E 01 0.1031E	01 -0.2062E 01 01 -0.2062E 01	-0.2994E-05 0.3094E 01
2 10	0.1758E C2 0.1758E C2	0.2339E 02	2 0.3125E 2 C.7812E	C1 -C.1562 C0 0.7812	2E 01 -0.1562E 2E 00 -0.1562E	01 - C. 2273E- C 01 0.2344E C	5 0.4125E 1 0.1031E	01 -0.2062E 01 0.1031E	01 -0.2062E 01 01 -C.2062E 01	-0.2994E-05 0.3094E 01
2 10	0.1758E C2	0.2339E 02	7CTAL	CO C.7812	**** EFFECT	01 0.2344E C	1	01 0.1031E	CI -C-2062E CI	0.3094E 01
2 10	0.1758E CZ	0.2339E 02	TCTAL EMPERATURE	SURFACE YIELD SIZ	**** EFFECT I NCPEMENTAL 0.1000F C	01 0.2344E C	TRAINS *** UMULATIVE 0.5000E 01	***** EFFEC INCREMENTAL C-3125E C1	C1 -C.2062E C1 TIVE CPEEP STR. SUM INCR. CU	0.3094E 01
ELEMENT	E-P SUM INCODE COLE TE	CREMENTAL	TCTAL EMPERATURE 0.15COE 02	SURFACE YIELD SIZ	**** EFFECT INCREMENTAL 0.1000F C	O1 0.2344E C	TRAINS *** UMULATIVE 0.5000E 01	***** EFFEC INCREMENTAL C-3125E C1	CI -C-2062E CI	0.3094E 01 AINS **** MULATIVE 0.4125E C1
2 10 ELEMENT NG. 1.C. 1 20	E-P SUM INCODE COLE TE	CREMENTAL	TCTAL EMPERATURE 0.15COE 02	SURFACE YIELD SIZ	**** EFFECT INCREMENTAL 0.1000F C	01 0.2344E C	TRAINS *** UMULATIVE 0.5000E 01	***** EFFEC INCREMENTAL C-3125E C1	TIVE CPEEP STR. SUM INCR. CUI	AINS **** PULATIVE
2 10 ELEMENT NC. 1.C. 1 20	E-P SUM INCODE COLE TE	CREMENTAL	TCTAL EMPERATURE 0.15COE 02	SURFACE YIELD SIZ	**** EFFECT INCREMENTAL 0.1000F C	01 0.2344E C	TRAINS *** UMULATIVE 0.5000E 01	***** EFFEC INCREMENTAL C-3125E C1	TIVE CPEEP STR. SUM INCR. CUI	AINS **** PULATIVE
2 10 ELEMENT NC. 1.C. 1 20	E-P SUM INCODE COLE TE	CREMENTAL	TCTAL EMPERATURE 0.15COE 02	SURFACE YIELD SIZ	**** EFFECT INCREMENTAL 0.1000F C	01 0.2344E C	TRAINS *** UMULATIVE 0.5000E 01	***** EFFEC INCREMENTAL C-3125E C1	TIVE CPEEP STR. SUM INCR. CUI	AINS **** PULATIVE
2 10 ELEMENT NG. 1.C. 1 20	E-P SUM INCODE COLE TE	CREMENTAL	TCTAL EMPERATURE 0.15COE 02	SURFACE YIELD SIZ	**** EFFECT INCREMENTAL 0.1000F C	01 0.2344E C	TRAINS *** UMULATIVE 0.5000E 01	***** EFFEC INCREMENTAL C-3125E C1	TIVE CPEEP STR. SUM INCR. CUI	0.3094E 01 AINS **** MULATIVE 0.4125E C1
2 10 ELEMENT NG. 1.C. 1 20	E-P SUM INCODE COLE TE	CREMENTAL	TCTAL EMPERATURE 0.1500E 02	SURFACE YIELD SIZ 0.3000E 0	**** EFFECT E INCPEMENTAL 1 0-1000F CT	11 0.2344E C	TRAINS *** UMULATIVE 0.5000E 01	**** EFFEC INCREMENTAL C.3125E CI 0.3125E OI	TIVE CPEEP STR. SUM INCR. CUI C.6125E C1 (0.3094E 01 AINS **** PULATIVE 0.4125E 01
ELEMENT NG. I.C. 1 20 2 10	E-P SUM IN CODE CODE TE 0 2 C 0 2 C	CREMENTAL WPERATURE T -1000F 01	TCTAL EMPERATURE 0.1500E 02	SURFACE YIELD SIZ 0.3000E 0 0.3000E 0	**** EFFECT F INCREMENTAL 1 0-1000F CT 1 0-1000F CT	TIVE PLASTIC S SUM INCR. C 0.7000E 01 0.7000E 01	TRAINS *** UMULATIVE 0.5000E 01 0.5000E 01	***** EFFEC INCREMENTAL C.3125E C1 0.3125E U1	TIVE CPEEP STR/ SUM INCR- CUI C.6125E C1 (0.6125E C1 (0.3094E 01 AINS **** PULATIVE 0.4125E 01 0.4125E 01
ELEMENT NC. T.C. 1 20 2 10 ELEMENT NG. T.C.	E-P SUM IN CODE CODE TE 0 2 C 0 2 C	CREMENTAL MPERATURE T 1.1000E 01 1.1000E 01	TCTAL EMPERATURE 0.1500E 02 ******** ******** ********	SURFACE YIELD SIZ 0.3000E 0 0.3000E 0	**** EFFECT E INCPEMENTAL O-1000F CT O-1000F CT	TIVE PLASTIC S SUM INCR. C 0.7000E 01 C.7000E 01	TRAINS *** UMULATIVE 0.5000E 01 0.5000E 01	**** EFFEC INCREMENTAL C.3125E CI 0.3125E OI	TIVE CPEEP STR. SUM INCR. CUI C.6125E C1 (0.3094E 01 AINS *** PULATIVE 0.4125E 01
ELEMENT NC. T.C. 1 20 2 10 ELEMENT NG. T.C.	E-P SUM IN CODE CODE TE 0 2 C 0 2 C	CREMENTAL MPERATURE T 1.1000E 01 1.1000E 01	TCTAL EMPERATURE 0.1500E 02 ******** ******** ********	SURFACE YIELD SIZ 0.3000E 0 0.3000E 0	**** EFFECT E INCPEMENTAL O-1000F CT O-1000F CT	TIVE PLASTIC S SUM INCR. C 0.7000E 01 C.7000E 01	TRAINS *** UMULATIVE 0.5000E 01 0.5000E 01	**** EFFEC INCREMENTAL C.3125E CI 0.3125E OI	TIVE CPEEP STR/ SUM INCR- CUI C.6125E C1 (0.6125E C1 (0.3094E 01 AINS *** PULATIVE 0.4125E 01

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9.2 THERMAL RATCHET

This is a thermal ratchet problem, involving thermal cycling in conjunction with a sustained mechanical load. The finite-element idealization and mechanical loading are shown in Figure 9.2-1. The thermal loading consists of an alternate heating and cooling of the left half of the structure (elements 1 and 2).

Because the stresses and thermal strains differ in the left and right halves of the structure, the BOPACE nodal-constraint option was used to allow vertical slip at the center. Thus the displacements at nodes 3-11 and 4-12 are constrained to be equal in the X direction, but are allowed to have different values in the Y direction. Poisson's ratio is taken as 0.5 so as to avoid small errors which would otherwise be induced by intermediate yielding within an increment.

Results are summarized in Table 9.2-1 for six increments, and the BOPACE input listing and printed output results are included at the end of this section. The mechanical loading is applied during the first increment and it then remains on the structure. In the second increment the thermal heating load is applied, and it results in plastic flow within the right side of the structure. Each succeeding heating and cooling cycle (two increments) results in continuing plastic flow and an increase of 0.5 in displacement. Note that this occurs even though a part of the structure is always elastic, because yielding occurs during alternate increments in the left and right sides. This type of behavior must be considered in thermal-mechanical cycling of engines.

PLATE = 2.0 x 1.0
THICKNESS = 10.0
TENSILE YIELD POINT = 1.0
THERMAL COEFFICIENT
OF EXPANSION = 1.0
E = 1.0
v = 0.5

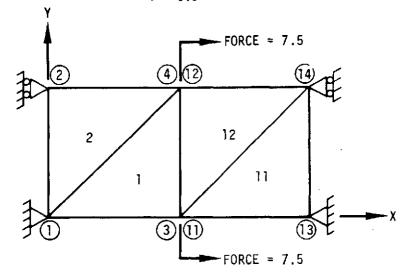


FIGURE 9.2-1: THERMAL RATCHET PROBLEM

TABLE 9.2-1: THERMAL RATCHET DATA

INCREMENT	DISPLACEMENT	TEMP. 1 & 2	TEMP. 11 & 12
-, 1	0.75	0	0
2	2.0	1.5	0
3	1.5 ′	0	0
4	2.5	1.5	0
5	2.0	0	0
6	3.0	1.5	0

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•0	1.0											
. 0	0.5	· —										
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1	0.0	0.0		······		 .	·					<u> </u>
2	0.0	1.0									-	
4	1.0 1.0 1.0	1.0					and the second second	·-·	·			· · · · · · · · · · · · · · · · · · ·
11 12	1.0	0.0 1.0								,		
13	2.0	1.0				·····					<u> </u>	
1 2 11	1	1 4	3 4	_				_				
11	1	11	3 4 2 1 13 14 12 11									
1				-		<u> </u>			· · ·	<u></u>		
13 11	1 -13 1 -13	13 12	2 -1 2 -13	2 14	1 -2	<u></u>						
		12	1 4								··-···	
3	1 7.5	4	1 7.5	_				_				
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NCREMEN	1.0 VT 1 (COLD)									*		
	1 0.0		2 0.0					-				

STARTING PROBLEM	
THERMAL RATCHET PROBLEM (WITH CONSTRAINED DOEL P. VOS 05/22/72	
SOLUTION METHOD CODE = 3	
MAXIMUM NO. STIFFNESS UPDATES PER INCREMENT = 2 MAXIMUM TOTAL ITERATIONS PER INCREMENT = 10	
MAXIMUM ELASTIC ITERATIONS PER INCREMENT = 7 MAXIMUM MAGNITUDE FOR ELASTIC-PLASTIC SUM CODE = 2-	
MAXIMUM REDUCTIONS = 1 . CONVERGENCE REDUCTION FACTOR = 0.50000E 00	
MAXIMUM SPECIFIED ERROR NORM = 0.10000E-04 FRACTION FROM END OF INCREMENT TO EVALUATE SLOPE = 0.10000E-00	
PLANE-STRESS PROBLEM NO. OF MATERIALS = 1	
DEFAULT THICKNESS = 0.10000F 02 FABRICATION TEMPERATURE = 0.0	
MATERIAL NO. 1 TEMPERATURE PERENDENT DODGETTES	17266
MATERIAL NO. 1 TEMPERATURE CEPENDENT PROPERTIES	
0.0 0.0	
0.1000E 02	
TEMPERATURE FLASTIC MOD. 0.0 0.1000F 01	
TEMPERATURE POISSONS RATIO	
0.0 0.5000E 00	

	1. PLASTICITY TYPE 2	TATINEMATIC CIPIE					
MATERIAL NO.	1, TEMPERATURE = 0.0						
PARAMETER	ISOTROPIC STRESS .	•				*	
0.0	0.100000 01	•					
0,10000E 03	0.10000E 01		<u> </u>				
PARAMETER	KINEMATIC SHAPE						
0.0	0.0						
0,10000E 03	0.0						
TEMPERATURE =	0.0						
PARAMETER	ISOTROPIC STRESS				1		
0.0	0.10000E 01						
0.10000E 03	0.10000E 01		<u> </u>		<u></u>		
PARAMETER	KINFMATIC SHAPE				•		
0.0	0.0						
0.10000E 03	0.0						
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9.					<u> </u>		
on MATERIAL NO.	1. CREEP TYPE 1				•		
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TIME 0.0	CREEP STRAIN				<u> </u>	 	
	0.1000E 01						
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MATERIAL NO.	1. TEMPERATURE = 0.0				·		
STRESS 0.1000E 01	CREEP FACTOR				· '		
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MATERIAL NO.	1. TEMPERATURE = 0.0					·	
STRESS	CREEP FACTOR						
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4		,	0	0.100000 01	0.100000 01	0	 		 	
5	11		0	0.100,00D 01	0.0	0				
6	1.2	?	0	0.100000 01	0.100000 01	0		 	 	
7	1.3	Į.	0	0.200000 01	0.0	0			•	
8	14		0	0.200000 01	0.100000 01	0				

NO.	I.O.	MATERIAL	THICKNESS	NODE 1	NODE 2	NADE 3	AREA		
. 1	L	11	0.10000 02	1	. 3	4	0.5000E 00	and the second second	
7	2	1	0.10000 02	4	2	ì	0.50005 00		10
3	11	11	0.1000D 02	11	13	14	0.50000 00		. <u>L</u>
4	12	1	0.1000D 02	14	12	11	0.5000F 00		
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1	COMPONENT 1	-1					
1	2	-1	 	 		 	
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14	Ŧ	-14				 	·
11	1	3	 	 			
12	1	4				 	

NO. OF LOAD	NEFERENCE CURVE	5 = 2					
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NODE CO	OMPONENT LOAD						·
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DAD REFERE	ENCE CURVE NO. EMPONENT LOAD	2 .					
	SHECHENT LOAD .						
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n. de load	INCREMENTS =	6					
NCREMENT	MAX. ITERATIONS	MECHANICAL CURVE FACTORS	CAEED LIME				
2	10	0.100006 01 0.0					
3	10	0.10000E 01 0.0 0.10000E 01 0.0	0.0 0.0			_	
4	10	0.100005 01 0.0	0.0				
6	10 10	0.10000E 01 0.0	0.0: 0.0				

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ELEMENT 1.1		11	12					
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	E N	D OF LO	AD INCRE	EMENT 1		······································		
	· · · · · · · · · · · · · · · · · · ·							_
CREEP TIME NO. ELASTIC O ELEM SPECIFIED A SPECIFIED N	LOAD CURVE FACTORS = INCREMENT = 0.0 ELEMENTS = 4. NO. P ENTS HAVE CHANGE ELAST AX. NO. STIFFNESS UPDAT AX. NO. ITERATIONS PER	LASTIC ELEMI IC TO PLAST: ES = 2, UPDATE =	ENTS = 0 IC. 0 FLEMP NO. UPDATES PE 10. NO. ITERAS	FREORMED ≈ 0 TIDVS PERFORMAD SINDE		NC PEMENT		D57
MECHANICAL CREEP TIME NO. ELASTIC O ELEN SPECIFIED A SPECIFIED A	LOAD CURVE FACTORS = INCREMENT = 0.0 ELEMENTS = 4. NO. P ENTS HAVE CHANGED ELAST AX. NO. STIFFNESS UPDAT	LASTIC ELEMI IC TO PLAST: ES = 2, UPDATE =	ENTS = 0 IC. 0 FLEMP NO. UPDATES PE 10. NO. ITERAS	FREORMED ≈ 0 TIDVS PERFORMED SINDE		<u>i</u>		D5-17266-
MECHANICAL CREEP TIME NO. ELASTIC O ELEN SPECIFIED A SPECIFIED A	LOAD CURVE FACTORS = INCREMENT = 0.0 ELEMENTS = 4. NO. P ENTS HAVE CHANGE ELAST AX. NO. STIFFNESS UPDAT AX. NO. ITERATIONS PER	LASTIC ELEMI IC TO PLAST: ES = 2, UPDATE =	ENTS = 0 IC. 0 FLEMP NO. UPDATES PE 10. NO. ITERAS	FREORMED ≈ 0 TIDVS PERFORMED SINDE		j Nederent		D517266-2
MECHANICAL CREEP TIME NO. ELASTIC O ELEN SPECIFIED A SPECIFIED A	LOAD CURVE FACTORS = INCREMENT = 0.0 ELEMENTS = 4. NO. P ENTS HAVE CHANGE ELAST AX. NO. STIFFNESS UPDAT AX. NO. ITERATIONS PER	LASTIC ELEMI IC TO PLAST: ES = 2, UPDATE =	ENTS = 0 IC. 0 FLEMP NO. UPDATES PE 10. NO. ITERAS	FREORMED ≈ 0 TIDVS PERFORMED SINDE		<u>i</u>		D517266-2
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MECHANICAL CREEP TIME NO. ELASTIC O ELEN SPECIFIED A SPECIFIED A SPECIFIED A	LOAD CURVE FACTORS = INCREMENT = 0.0 ELEMENTS = 4. NO. P ENTS HAVE CHANGE ELAST AX. NO. STIFFNESS UPDAT AX. NO. ITERATIONS PER	LASTIC ELEMI TIC TO PLAST ES = 2, UPDATE = ROR = C.106	ENTS = 0 IC, 0 FLEMP NO. UPDATES PE 10: NO. ITERAT 00E-04. ACTUAL	FREDRMED = 0 1104 S PERFORMED SINCE EFROR = 0.74375-06		<u>i</u>		D5-17266-2
MECHANICAL CREEP TIME NO. ELASTIC O ELEP SPECIFIED A SPECIFIED A SPECIFIED A	LOAD CURVE FACTORS = INCREMENT = 0.0 ELEMENTS = 4. NO. P ENTS HAVE CHANGED ELAST AX. NO. STIFFNESS UPDAT AX. NO. ITERATIONS PER AX. UNBALANCED-FORCE ER	LASTIC ELEMI TIC TO PLAST ES = 2, UPDATE = ROR = C.106	ENTS = 0 IC, 0 FLEMP NO. UPDATES PE 10: NO. ITERAT 00E-04. ACTUAL	FREDRATED = 0 TIDNS PERFORMED SINCE EFROR = 0.74375-06		<u>i</u>		D5-17266-2
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ELEM		E-P SUM IN	NC REMENTAL	TOTAL	SURF AC F	**** FFF6CT	TVF PLASTIC S	TRAINS ***	***** FFEFCT	IVE CREEP	STRAINS ****
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INCREMENT 3	(COLD)	AND Z-LOADS FOR LOAD INCOSPIENT ?		<u> </u>
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	END OF LO	AD INCREMENT 3		
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MECHANICAL ! Creep time !	DAD CURVE FACTORS = 0.1000F 01.			3
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MECHANICAL ICREEP TIME INO. ELASTIC 2 ELEME SPECIFIED MASSPECIFIED MAS	DAD CURY F FACTORS = 0.1000 F 01. INCREMENT = 0.0 ELEMENTS = 2, NO. PLASTIC FLEME INTS HAVE CHANGED ELASTIC TO PLASTI AX. NO. STIFFNESS UPDATES = 2. AX. NO. ITERATIONS PER UPDATF = 1. AX. UNBALANCED-FORCE ERROR = 0.100 ******* CUMULATIVE INTERNAL FOR *********** U -0.5000001E 01 0.268855TE-07 -0.4999999E 01 -0.1132491E-05 D.5000000E 01 -0.3404473E-05 0.4999999E 01 0.4510080E-05 0.2500003E 01 -0.3394331E-07 0.2500003E 01 -0.3394331E-07	ENTS = 2 IC. 2 FLEMENTS PLASTIC TO FLASTIC DURI NC. UPDATES PEPEDRMED = 0 10, NO. ITERATIONS PEPEDRMED SINCE LAST I DE-Q4. ACTUAL ERFOR = 2.3019F-06 PCES AND DISPLACEMENTS ****** ***** DISPLACEMENTS ****** U 0.0 0.0 0.0 0.1500000E 01 0.2530046F-06 0.1500000E 01 0.749990D 00 0.1500000E 01 0.749990D 00 0.1500000E 01 0.7500002E 00 0.1500000E 01 0.7500002E 00	•	
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MECHANICAL CREEP TIME INO. ELASTIC 2 ELEME SPECIFIED MASSPECIFIED MASS		ENTS = 2 IC. 2 FLEMENTS PLASTIC TO FLASTIC DURI NC. UPDATES PEPERAMED = 0 10, NO. ITERATIONS PERFORMED SINCE LAST I DE-04 LACTUAL ERFOR = 2.3010 F-06 PCES AND DISPLACEMENTS ******* ***** DISPLACEMENTS ****** U 0.0	•	
CREEP TIME 1 NO. ELASTIC 2 ELEME SPECIFIED MA SPECIFIED MA ** NODE ** NO. I.D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13		ENTS = 2 IC. 2 FLEMENTS PLASTIC TO FLASTIC DURI NC. UPDATES PEPERAMED = 0 10, NO. ITERATIONS PERFORMED SINCE LAST I DE-04 LACTUAL ERFOR = 2.3010 F-06 PCES AND DISPLACEMENTS ******* ***** DISPLACEMENTS ****** U 0.0	•	

FLEMENT	*** THERMAL	CTDATMC ###	* *****	****		commo FLASIIC	STRAINS **	****	*****	**********
	INCREMENTAL			YY		XY	XX		Δ11VF ***	**************************************
11	1 -0.1500E 01	0.0	C. 50005	00 -0.25005	00 -0.2500F	90 0.2631F-0	6 0 -1000F	01 -0 50005	00 = 0, 5000	0F 00 -0.5575E-07
2 2	2 -0.1500E 01	0.0	0.5000E	00 -0.2500E	00 -0.2500E	00 -0-8941E-0	7 0.1000F	01 -0.50005	00 -0.5000	DE 00 0.3874E-06
	0.0	0.0	0.5000E	00 -0.25005	00 -0.2500F	00 -0.11205-0	6 -0.5000E			0 00 -0.1554E-07
4 12	2 0.0	0.0	C.5000E	00 -0.25005	00 -0.250CE	00 0.2086E-0	6 -0.5 000F			0.5960F-08
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			****	***	*************	**** PLASTIC	STRAINS **	******	रीत्रकाथ नेपाधक ्र क	****
	**** PLASTI INCREMENTAL		- ####################################			******				****************
NU IAUA	INCKEMENTAL	CUMULATIVE	xx	YY	7.7	XY	<u>xx</u>	ΥΥ	77	XY
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	0.5000E 00			00 -0-2500F	00 -0-2500F	00 0.89415-0	7 0.5000E	30 -0,2500F	$\frac{39}{09} = 3.2500$	DF 00 0.8941F-07
	0.0	0.1000E 01		0.0	0.0	0.0				05 00 0.77826-07
4 12	0.0	0.1000E 01	0.0	0, 0	0. o	0.0				3E 00 -0.1550E-06
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ELEMENT	EFFECTIVE	EFFECT IVE	****	**********	*********	UMIJLATIVE STRE	SS QUANTITE	F5 *****	表示 於於此來內亦素 *	*****************
NO. I.D.		STRESS	XX	YY	77	XY	XX	AA.	5.55 *******	**************************************
								· · ·		<u>^T</u>
	0.0	0.1000E 01		0.0	0.0	9.0	0.1000F	01 0.4437E-	06 0.0	-0.3717E-07
	0.0	0.1000E 01		0.0	0.0	0.0		01 0.3179E-		0.258 3E-06
	0.0	0.5000E 00		0.0	0.0	0.0		00 -0.2583E-		-0.1109F-07
4 12	0.0	0.5000E 00	0.0	0.0	0.0	0.0	-0.5000E	00 0.1783E-	07 .0.0	0.3974E-08
ELEMENT	E-P SUM IN	CREMENTAL	TOTAL	SURF AC F	****	IVE PLASTIC ST	FRAINS ***	***** EEEEU	TIVE CREEK	STRAINS ***
NO. I.D.	CODE CODE TE			YIFLD STZE	I NOF EMENTAL	SUM INCP. OF	IMULATIVE -	THEREMENTAL		CUMULATIVE
1 1			0.0	0.1000F 01		<u>0.5000F 00</u>		0.0	0.0	0.0
2 2	-		0.0	0.1000F 01	0.5000E 00			0:0	0. 7	0.9
3 11 4 12	<u>-1 -2 0</u>		0.0	0.1000E 01	0, 0		0.1000F 01	0.1	0.0	0.0
• 12	-1 -2 0	• 0	0.0	0.10005 01	a . n	0.10005 01	0, 1000F 01	0.0	0.0	0.0
		- <u>-</u>								
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		· .								
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****		S AND Z-LOADS FOR LOAD INCREMENT 4	
INCREMENT 4	(HOT)		
ELEMENT I.D.	. 1 2 11	12	
	0.15000F 01 0.15000F 01 0.0	_0.0	·
Z-LOAD (0.0	0.0	
ITEDATIVE E	RROR = 0.12500E 01		
	RROR = 0.36616E-05		
	RROR = 0.14142E 00		
	RRCR = 0.14143E 00	· · · · · · · · · · · · · · · · · · ·	
	RRCR = 0.14143E 00		•
	RROR = 0.10874E+05 RROR = 0.17333E+05		
E I COM I TAN		·	
	"		
·	•		
	END OF I	OAD INCREMENT 4	, . <u></u>
INCREMENT 4	(HOT) LOAD CURVE FACTORS = 0.1000E 01	1 0 0	
	INCREMENT = 0.0	11 0.0	
	ELEMENTS = 2. NC. PLASTIC ELI	FM ENTS = 2	
O 2 ELEM	<u>ENTS HAVE CHANGED ELASTIC TO PLAS</u>	STIC: 2 FLEMENTS PLASTIC TO ELASTIC DURING THIS INCREMENT	
∾ SPECIFIED M.	AX. NO. STIFFNESS UPDATES # 2	2. NO. UPDATES PERFORMED = - 0	
COCCICIED W	AN NO TERRETORS DES RESSAUS	10 NO ITERATIONS OFFICENCE CINCS LAST MODATE	
SPECIFIED M	AX. NO. ITERATIONS PER UPDATE =	10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE = 7	
SPECIFIED M	AX. NO. ITERATIONS PER UPDATE =	10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE = 7 1000E-04, ACTUAL EPFOR = 0.1733E-05	
SPECIFIED M	AX. NO. ITERATIONS PER UPDATE =	10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE = 7 1000E-04, ACTUAL EPFOR = 0.1733E-05	
SPECIFIED M	AX. NO. ITERATIONS PER UPDATE =	10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE = 7 1000E-04, ACTUAL EPFOR = 0.1733E-05	
SPECIFIED M	AX. NO. ITERATIONS PER UPDATE =	10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE = 7 1000E-04, ACTUAL EPFOR = 0.1733E-05	
SPECIFIED M	AX. NO. ITERATIONS PER UPDATE = AX. UNBALANCEO-FORCE ERROR = 0.1	1000E-04, ACTUAL EPFOR = 0.1733E-05	
SPECIFIED M	AX. NO. ITERATIONS PER UPDATE = AX. UNBALANCED-FORCE ERROR = 0.1 ***********************************	FORCES AND DISPLACEMENTS	
SPECIFIED M SPECIFIED M	AX. NO. ITERATIONS PER UPDATE = AX. UNBALANCED-FORCE ERROR = 0.1 ****** CUMULATIVE INTERNAL F ******* FORCES *******	FORCES AND DISPLACEMENTS ## **** ***** DISPLACEMENTS ************************************	
SPECIFIED M	AX. NO. ITERATIONS PER UPDATE = AX. UNBALANCED-FORCE ERROR = 0.1 ***********************************	FORCES AND DISPLACEMENTS	
** NODE ** NO. 1.D.	######################################	FORCES AND DISPLACEMENTS ******* ***** DISPLACEMENTS ****** U V D.O O.O	
** NODE ** NO. 1.D. 1 1 2 2	****** CUMULATIVE INTERNAL F ******* FORCES ******* U -0.249999F 01 0.7309890E-05 -0.249999F 01 -0.7490318E-05	##### DISPLACEMENTS ####################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3	****** CUMULATIVE INTERNAL F ******* FORCES ******* U -0.2499999F 01 0.7309890E-05 -0.2499999F 01 0.2028176E-05	###### DISPLACEMENTS ####################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3 4 4	****** CUMULATIVE INTERNAL F ******* FORCES ******** -0.2499997F 01 -0.7309890E-05 0.2499997F 01 -0.2028176E-05 0.2499997F 01 -0.1847749E-05	##### DISPLACEMENTS ####################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 4 5 11	****** CUMULATIVE INTERNAL F ****** FORCES ******* -0.249999F 01 0.7309890E-05 -0.249999F 01 0.2028176E-05 0.249999F 01 -0.1847749E-05 0.249999F 01 -0.1561245E-05	######################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3 4 4	****** CUMULATIVE INTERNAL F ******* FORCES ******** -0.2499997F 01 -0.7309890E-05 0.2499997F 01 -0.2028176E-05 0.2499997F 01 -0.1847749E-05	##### DISPLACEMENTS ####################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12	****** CUMULATIVE INTERNAL F ******* FORCES ******* -0.249999E 01 0.7309890E-05 -0.249999F 01 0.2028176E-05 0.249999F 01 -0.1561245E-05 0.499999E 01 0.2296018E-05	##### DISPLACEMENTS ####################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	****** CUMULATIVE INTERNAL F ****** FORCES ******* -0.249999F 01 0.7309890E-05 -0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.499999F 01 0.22280906E-05	######################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	****** CUMULATIVE INTERNAL F ****** FORCES ******* -0.249999F 01 0.7309890E-05 -0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.499999F 01 0.22280906E-05	######################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	****** CUMULATIVE INTERNAL F ****** FORCES ******* -0.249999F 01 0.7309890E-05 -0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.499999F 01 0.22280906E-05	######################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	****** CUMULATIVE INTERNAL F ****** FORCES ******* -0.249999F 01 0.7309890E-05 -0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.499999F 01 0.22280906E-05	######################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	****** CUMULATIVE INTERNAL F ****** FORCES ******* -0.249999F 01 0.7309890E-05 -0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.499999F 01 0.22280906E-05	######################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	****** CUMULATIVE INTERNAL F ****** FORCES ******* -0.249999F 01 0.7309890E-05 -0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.499999F 01 0.22280906E-05	######################################	
** NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	****** CUMULATIVE INTERNAL F ****** FORCES ******* -0.249999F 01 0.7309890E-05 -0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.249999F 01 0.2028176E-05 0.499999F 01 0.22280906E-05	######################################	

		*** THERMAL				- •	****		**** CUMULAT	-	
NU.	[+D+	INCREMENTAL	COMULATIVE	XX	, YY	77	XY	XX	YY	7.7	XY
1	1	0.1500E 01	0.15006.01	-0.500DE (na a. 25 ao 5	nn n 250es	00 -0.2776F-05		nn _n 2500E no	0 35005	90 -0.3333E-06
2		0.1500E 01							00 -0 2500F 00	1 -0 250CE	00 0.3874E-06
3			0.0								00 -0.4721F-07
4		0.0	0.9	-0.5000E	00 0.2500E	00 0.2500E	00 -0.17926-06	-0.1000F	01 0.5000E 00	0.50005	00 -0.1732E-06
		•									
			0				,				
EL E	MENT	**** PLAST!	IC WORK ****				***** PLASTIC		randa CUMII AT		
		INCREMENTAL		XX	YY	7.7	XY	XX	YY	2.2	XY
											
		_ 0.0	0.5000E 00		0.0	0.0	0.0				00 -0.561ZE-07
. 2	2	0.0	0.5000E 00	0.0	0.0	0.0	0.0	0.5000E (00 -0.2509E 00	-0.2500E	00 0.8941F-07
3	$-i\tilde{r}$	0.5000E 00	0.1500E 01	-0.5000E (00 0.2500F (00 0.2500E	<u>00 -0,1609E-07</u>	-0.1500F	01 0.7500E 00	0.750CE	00 0.61738-07
4	12	n*2000E 00	0.1500E 0I	-0.5000E 0	0.2590E (00 0.25005	00 ∼0.2943E-07	7 -0.1500E	01 0.7500F 00	0.7500F (00 -0.1844E-06
.4				•							
									 	<u> </u>	
									5 ********		
	TENT	EFFECTIVE CENTER	EFFECTIVE	*********			****		***** STRES		
INCLE		CENTER	STRESS	XX	YY		ХУ	XX '	· YY		XY
1	1	0.0	0.5000€ 00	0-0	0- 0	0.0	0.0	0 E0005 (10 -0 47705 04	0.0	. 0 22225 04
1 2	1 2	0.0	0.5000E 00	0.0	0.0	0.0	0.0		00 -0.6278E-06		-0. 2222E-06
	_	0.0	0.5000E 00	0.0	0.0	0.0	0.0	0.5000E (00 -0.1340E-05	0.0	0.2583E-06
2 3	11						0.0 0.0	0.5000E 0	00 -0.1340E-05 01 -0.2583E-07	0.0	0.2583E-06 -0.3147E-07
	11	0.0 0.0	0.5000E 00 0.1000E 01	0.0 0.0	0.0 0.0	0.0 0.0	0.0	0.5000E 0	00 -0.1340E-05	0.0	0.2583E-06
	11	0.0 0.0	0.5000E 00 0.1000E 01	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	0.5000E 0	00 -0.1340E-05 01 -0.2583E-07	0.0	0.2583E-06 -0.3147E-07
3 4 ELE/	11 12	0.0 0.0 0.0	0.5000E 00 0.1000E 01 0.1000E 01	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0	0.5000E (-0.1000E (-0.1000E (00 -0.1740F-05 01 -0.2563E-07 01 0.3427F-06	0.0 0.0 .0.0 .0.0	0.2583E-06 -0.3147E-07 -0.1155F-06
3 4 ELE/	11 12	E-P SUM IN	0.5000E 00 0.1000E 01 0.1000E 01	O.O O.O O.O TOTAL	O.O O.O O.O SURFACE	0.0 0.0 0.0 0.0	0.0 0.0 0.0 0.0 IVE PLASTIC ST	0.5000E (-0.1000E (-0.1000E (00 -0.1740F-05 01 -0.2583E-07 01 0.3437F-06 ***** EFFECTI INCREMENTAL S	VE CREEP S	0.2583E-06 -0.3147E-07 -0.1155F-06
ELEI NO.	11 12 1ENT 1. D.	0.0 0.0 0.0 0.0 E-P SUM IN COCE CODE TE	0.5000E 00 0.1000E 01 0.1000E 01 0.1000E 01	O.O O.O O.O TOTAL EMPERATURE 0.1500E 01	0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01	0.0 0.0 0.0 **** FFECT INCREMENTAL 0.0	0.0 0.0 0.0 0.0 IVE PLASTIC ST SUM INCP. CU	0.5000E (-0.1000E (-0.1000E (-0.1000E (PAINS *** MILATIVE 9.5000E (0)	00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S	0.0 0.0 .0.0 .0.0 VE CPEEP S UM INCR. (0.2583E-06 -0.3147E-07 -0.1155E-06 TRAINS ****
3 4 ELE/	11 12 1ENT 1. D.	0.0 0.0 0.0 0.0 E-P SUM IN COCE CODE TO -1 -2 C	0.5000E 00 0.1000E 01 0.1000E 01 CREMENTAL EMPERATURE TE 1.1500E 01 (0.1500E 0	0.0 0.0 0.0 0.0 TOTAL EMPERATURE 0.1500E 01	0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01	0.0 0.0 0.0 0.0 **** FFFECT INCREMENTAL 0.0	0.0 0.0 0.0 0.0 IVE PLASTIC ST SUM INCP. CO 0.5000F 00 0.5000F 00	0.5000E (-0.1000E (-0.1000E (-0.1000E (D.1000E (0.5000E (00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S 0.0	0.0 0.0 .0.0 .0.0 VE CREEP S' SUM INCR. (0.0 0.0	0.2583E-06 -0.3147E-07 -0.1155E-06
ELEI NO.	11 12 1ENT I. D. 1	0.0 0.0 0.0 0.0 E-P SUM IN CODE CODE TE -1 -2 C -1 -2 C	0.5000E 00 0.1000E 01 0.1000E 01 CREMENTAL EMPERATURE TE 0.1500E 01 (0)	0.0 0.0 0.0 0.0 TOTAL EMPERATURE 0.1500E 01 0.1500E 01	0.0 0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01 0.1000E 01	0.0 0.0 0.0 **** FFECT INCREMENTAL 0.0 0.0 0.5000F 00	0.0 0.0 0.0 0.0 1VE PLASTIC ST SUM INCP. CU 0.5000F 00 0.5000F 00 0.1500F 01	0.5000E (-0.1000E (-0.1000E (-0.1000E (DAINS *** J*ULATIVE 9.5000F 00 0.5000F 00	00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S 0.0 0.0 0.0	0.0 0.0 .0.0 .0.0 .0.0 .0.0 0.0 0.0 0.0	0.2583E-06 -0.3147E-07 -0.1155E-06 TRAINS **** CUMULATIVE 0.0 0.0
ELEI NO.	11 12 1ENT 1. D.	0.0 0.0 0.0 0.0 E-P SUM IN CODE CODE TE -1 -2 C -1 -2 C	0.5000E 00 0.1000E 01 0.1000E 01 CREMENTAL EMPERATURE TE 0.1500E 01 00 0.1500E 01 00	0.0 0.0 0.0 0.0 TOTAL EMPERATURE 0.1500E 01 0.1500E 01	0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01	0.0 0.0 0.0 **** FFECT INCREMENTAL 0.0 0.0 0.5000F 00	0.0 0.0 0.0 0.0 IVE PLASTIC ST SUM INCP. CO 0.5000F 00 0.5000F 00	0.5000E (-0.1000E (-0.1000E (-0.1000E (DAINS *** J*ULATIVE 9.5000F 00 0.5000F 00	00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S 0.0 0.0 0.0	0.0 0.0 .0.0 .0.0 VE CREEP S' SUM INCR. (0.0 0.0	0.2583E-06 -0.3147E-07 -0.1155E-06
ELEI NO.	11 12 1ENT I. D. 1	0.0 0.0 0.0 0.0 E-P SUM IN CODE CODE TE -1 -2 C -1 -2 C	0.5000E 00 0.1000E 01 0.1000E 01 CREMENTAL EMPERATURE TE 0.1500E 01 (0)	0.0 0.0 0.0 0.0 TOTAL EMPERATURE 0.1500E 01 0.1500E 01	0.0 0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01 0.1000E 01	0.0 0.0 0.0 **** FFECT INCREMENTAL 0.0 0.0 0.5000F 00	0.0 0.0 0.0 0.0 1VE PLASTIC ST SUM INCP. CU 0.5000F 00 0.5000F 00 0.1500F 01	0.5000E (-0.1000E (-0.1000E (-0.1000E (DAINS *** J*ULATIVE 9.5000F 00 0.5000F 00	00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S 0.0 0.0 0.0	0.0 0.0 .0.0 .0.0 .0.0 .0.0 0.0 0.0 0.0	0.2583E-06 -0.3147E-07 -0.1155E-06 TRAINS **** CUMULATIVE 0.0 0.0
ELEI NO.	11 12 1ENT I. D. 1	0.0 0.0 0.0 0.0 E-P SUM IN CODE CODE TE -1 -2 C -1 -2 C	0.5000E 00 0.1000E 01 0.1000E 01 CREMENTAL EMPERATURE TE 0.1500E 01 (0)	0.0 0.0 0.0 0.0 TOTAL EMPERATURE 0.1500E 01 0.1500E 01	0.0 0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01 0.1000E 01	0.0 0.0 0.0 **** FFECT INCREMENTAL 0.0 0.0 0.5000F 00	0.0 0.0 0.0 0.0 1VE PLASTIC ST SUM INCP. CU 0.5000F 00 0.5000F 00 0.1500F 01	0.5000E (-0.1000E (-0.1000E (-0.1000E (DAINS *** J*ULATIVE 9.5000F 00 0.5000F 00	00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S 0.0 0.0 0.0	0.0 0.0 .0.0 .0.0 .0.0 .0.0 0.0 0.0 0.0	0.2583E-06 -0.3147E-07 -0.1155E-06 TRAINS **** CUMULATIVE 0.0 0.0
ELEI NO.	11 12 1ENT I. D. 1	0.0 0.0 0.0 0.0 E-P SUM IN CODE CODE TE -1 -2 C -1 -2 C	0.5000E 00 0.1000E 01 0.1000E 01 CREMENTAL EMPERATURE TE 0.1500E 01 (0)	0.0 0.0 0.0 0.0 TOTAL EMPERATURE 0.1500E 01 0.1500E 01	0.0 0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01 0.1000E 01	0.0 0.0 0.0 **** FFECT INCREMENTAL 0.0 0.0 0.5000F 00	0.0 0.0 0.0 0.0 1VE PLASTIC ST SUM INCP. CU 0.5000F 00 0.5000F 00 0.1500F 01	0.5000E (-0.1000E (-0.1000E (-0.1000E (DAINS *** J*ULATIVE 9.5000F 00 0.5000F 00	00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S 0.0 0.0 0.0	0.0 0.0 .0.0 .0.0 .0.0 .0.0 0.0 0.0 0.0	0.2583E-06 -0.3147E-07 -0.1155E-06 TRAINS **** CUMULATIVE 0.0 0.0
ELEI NO.	11 12 1ENT I. D. 1	0.0 0.0 0.0 0.0 E-P SUM IN CODE CODE TE -1 -2 C -1 -2 C	0.5000E 00 0.1000E 01 0.1000E 01 CREMENTAL EMPERATURE TE 0.1500E 01 (0) 0.1500E 01 (0)	0.0 0.0 0.0 0.0 TOTAL EMPERATURE 0.1500E 01 0.1500E 01	0.0 0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01 0.1000E 01	0.0 0.0 0.0 **** FFECT INCREMENTAL 0.0 0.0 0.5000F 00	0.0 0.0 0.0 0.0 1VE PLASTIC ST SUM INCP. CU 0.5000F 00 0.5000F 00 0.1500F 01	0.5000E (-0.1000E (-0.1000E (-0.1000E (DAINS *** J*ULATIVE 9.5000F 00 0.5000F 00	00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S 0.0 0.0 0.0	0.0 0.0 .0.0 .0.0 .0.0 .0.0 0.0 0.0 0.0	0.2583E-06 -0.3147E-07 -0.1155E-06 TRAINS **** CUMULATIVE 0.0 0.0
ELEI NO.	11 12 1ENT I. D. 1	0.0 0.0 0.0 0.0 E-P SUM IN CODE CODE TE -1 -2 C -1 -2 C	0.5000E 00 0.1000E 01 0.1000E 01 CREMENTAL EMPERATURE TE 0.1500E 01 (0) 0.1500E 01 (0)	0.0 0.0 0.0 0.0 TOTAL EMPERATURE 0.1500E 01 0.1500E 01	0.0 0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01 0.1000E 01	0.0 0.0 0.0 **** FFECT INCREMENTAL 0.0 0.0 0.5000F 00	0.0 0.0 0.0 0.0 1VE PLASTIC ST SUM INCP. CU 0.5000F 00 0.5000F 00 0.1500F 01	0.5000E (-0.1000E (-0.1000E (-0.1000E (DAINS *** J*ULATIVE 9.5000F 00 0.5000F 00	00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S 0.0 0.0 0.0	0.0 0.0 .0.0 .0.0 .0.0 .0.0 0.0 0.0 0.0	0.2583E-06 -0.3147E-07 -0.1155E-06 TRAINS **** CUMULATIVE 0.0 0.0
ELEI NO.	11 12 1ENT I. D. 1	0.0 0.0 0.0 0.0 E-P SUM IN CODE CODE TE -1 -2 C -1 -2 C	0.5000E 00 0.1000E 01 0.1000E 01 CREMENTAL EMPERATURE TE 0.1500E 01 (0) 0.1500E 01 (0)	0.0 0.0 0.0 0.0 TOTAL EMPERATURE 0.1500E 01 0.1500E 01	0.0 0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01 0.1000E 01	0.0 0.0 0.0 **** FFECT INCREMENTAL 0.0 0.0 0.5000F 00	0.0 0.0 0.0 0.0 1VE PLASTIC ST SUM INCP. CU 0.5000F 00 0.5000F 00 0.1500F 01	0.5000E (-0.1000E (-0.1000E (-0.1000E (DAINS *** J*ULATIVE 9.5000F 00 0.5000F 00	00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S 0.0 0.0 0.0	0.0 0.0 .0.0 .0.0 .0.0 .0.0 0.0 0.0 0.0	0.2583E-06 -0.3147E-07 -0.1155E-06 TRAINS **** CUMULATIVE 0.0 0.0
ELEI NO.	11 12 1ENT I. D. 1	0.0 0.0 0.0 0.0 E-P SUM IN CODE CODE TE -1 -2 C -1 -2 C	0.5000E 00 0.1000E 01 0.1000E 01 CREMENTAL EMPERATURE TE 0.1500E 01 (0) 0.1500E 01 (0)	0.0 0.0 0.0 0.0 TOTAL EMPERATURE 0.1500E 01 0.1500E 01	0.0 0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01 0.1000E 01	0.0 0.0 0.0 **** FFECT INCREMENTAL 0.0 0.0 0.5000F 00	0.0 0.0 0.0 0.0 1VE PLASTIC ST SUM INCP. CU 0.5000F 00 0.5000F 00 0.1500F 01	0.5000E (-0.1000E (-0.1000E (-0.1000E (DAINS *** J*ULATIVE 9.5000F 00 0.5000F 00	00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S 0.0 0.0 0.0	0.0 0.0 .0.0 .0.0 .0.0 .0.0 0.0 0.0 0.0	0.2583E-06 -0.3147E-07 -0.1155E-06 TRAINS **** CUMULATIVE 0.0 0.0
ELEI NO.	11 12 1ENT I. D. 1	0.0 0.0 0.0 0.0 E-P SUM IN CODE CODE TE -1 -2 C -1 -2 C	0.5000E 00 0.1000E 01 0.1000E 01 CREMENTAL EMPERATURE TE 0.1500E 01 (0) 0.1500E 01 (0)	0.0 0.0 0.0 0.0 TOTAL EMPERATURE 0.1500E 01 0.1500E 01	0.0 0.0 0.0 0.0 SURFACE YIELD SIZE 0.1000E 01 0.1000E 01	0.0 0.0 0.0 **** FFECT INCREMENTAL 0.0 0.0 0.5000F 00	0.0 0.0 0.0 0.0 1VE PLASTIC ST SUM INCP. CU 0.5000F 00 0.5000F 00 0.1500F 01	0.5000E (-0.1000E (-0.1000E (-0.1000E (DAINS *** J*ULATIVE 9.5000F 00 0.5000F 00	00 -0.1740E-05 01 -0.2583E-07 01 0.3437E-06 ***** EFFECTI INCREMENTAL S 0.0 0.0 0.0	0.0 0.0 .0.0 .0.0 .0.0 .0.0 0.0 0.0 0.0	0.2583E-06 -0.3147E-07 -0.1155E-06 TRAINS **** CUMULATIVE 0.0 0.0

NCREMENT 5 (•						
LEMENT I.D.		2 11	. 12				
EMP. 0.			0.0				
-LOAD 0.	0 0.	0.0	0.0				
TERATIVE ERR	CR = 0.1250	00E 01					
TERATIVE ERR							
TERATIVE ERR TERATIVE ERR					•		
				- Contract C			
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		·			•		
		5 N D D F 4 O					
		END OF LO	A D I V C R	<u> </u>	<u> </u>		
NCDEMENT -	200.01						
NCREMENT 5 (IECHANICAL LO		TORS = 0.1000E 01.	0_0	<u>.</u>			
REEP TIME IN	ICREMENT = C	0.0					
O. ELASTIC E	LEMENTS =	2. NO. PLASTIC FLEMS	NTS = 2			•	
		IGED ELASTIC TO PLASTI IES <u>S updates = 2.</u>		ENTS PLASTIC TO SLASTIC D	URING THIS INCREMENT		
PECIFIED MAX	La NO TERAT	TONS PER UPDATE =	10. NO. TTERA	TIONS PERFORMED SINCE LAS	T UPDATE = 4 ·	 .	
PECLETED MAX	UNBAL ANCED	-FORCE ERROR = 0.100	DE-04. AC TUAL	ERROR = 0.4305E-06	T OF OF THE		
PECIFIED MAX	UNBAL ANCED	-FORCE ERROR = 0.10(DOE-04. AC TUAL	ERROR = 0.4305E-06	T OF OF O		
PECIFIED MAX	UNBAL ANCEC	-FORCE ERROR = 0.100	DOE-04. AC TUAL	ERROR = 0.4305E-06	·		5
	****** CL	-FORCE ERROR = 0.10(CES AND DISPL	ERROR = 0.4305E-06	·		7.20
* NODE **	******** CU	MULATIVE INTERNAL FOR	DOE-04. AT TUAL	ACEMENTS ****** PLACEMENTS ******	·		2-002/
	****** CL	-FORCE ERROR = 0.10(CES AND DISPL	ERROR = 0.4305E-06	·		0000
* NODE ** NO. 1. D.	**************************************	MULATIVE INTERNAL FOR FORCES ******** 01 -0.8030302E-06	DOE-04. AT TUAL	ACEMENTS ****** PLACEMENTS ******	·		2-0027
* NODE ** NO. 1.D.	****** CU ******* U -0.5000000F -0.499999E	MULATIVE INTERNAL FOR FORCES ************************************	CES AND DISPLEMENT DIS	ACEMENTS ****** PLACEMENTS ***** V 0.0 -0.1000000 01	·		2002
* NODE ** NO. 1. D. 1 1 2 2 3 3	******* CU ******** U -0.5000000F -0.499999E 0.4999999E	MULATIVE INTERNAL FOR FORCES ******** V 01 -0.8030302E-06 01 -0.2111092F-06 01 -0.1889095E-05	0.0 0.0 0.0 0.20200000	ACEMENTS ****** PLACEMENTS ***** V 0.0 -0.1000000E 01 01 -0.5106533F-07	·		2002
* NODE ** NO. 1. D. 1 1 2 2 3 3 4 4	****** CU ******* -0. 5000000F -0. 4999999E 0. 499999E 0. 5000000F	DEGREE ERROR = 0.10() MULATIVE INTERNAL FOR FORCES ******* 01 -0.8030302E-06	00E-04. ACTUAL CES AND DISPL ***** DIS 0.0 0.0 0.2010000E 0.2030001F	ACEMENTS ****** PLACEMENTS ***** V 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.9000905 00	·		0000
* NODE ** NO. 1. D. 1 1 2 2 3 3 4 4	****** -0. 5000000F -0. 4999999 0. 4999999 0. 5000004 0. 250004	MULATIVE INTERNAL FOR FORCES ******** V 01 -0.8030302E-06 01 -0.2111092F-06 01 -0.1889095E-05	0.0 0.0 0.2020001F 0.2020001F	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.51065335-07 01 -0.1974335-07	·		0000
* NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		20000
* NODE ** NO. I.D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	OFFIRCE ERROR = 0.10(MULATIVE INTERNAL FORFORCES ******** O1 -0.8030302E-06	0.0 0.0 0.2000001F 0.2000001F 0.2000001F 0.2000001F	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.51065335-07 01 -0.1974335-07 01 -0.1974335-07 01 0.197400000 01	·		20000
* NODE ** NO. I.D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		20000
* NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		20000
* NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		20000
* NODE ** NO. 1. D. 1	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		20000
* NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		2002
* NODE ** NO. 1. D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		2002
* NODE ** NO. I.D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		2002
* NODE ** NO. I.D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		2002
* NODE ** NO. I.D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		2002
* NODE ** NO. I.D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		2002
* NODE ** NO. I.D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		2002
* NODE ** NO. I.D. 1 1 2 2 3 3 4 4 5 11 6 12 7 13	******* CU ******** -0. 5000000F -0. 4999999E 0. 4999999E 0. 2500000F 0. 2500004E -0. 2500002E	DEFORCE ERROR = 0.100 MULATIVE INTERNAL FOR FORCES ******** 01	0.0 0.0 0.0 0.20203015 0.20203015 0.20203015 0.20203015	ACEMENTS ******* PLACEMENTS ***** 0.0 -0.10000000 01 01 -0.91065335-07 01 -0.900000 01 01 -0.1070000 01 01 -0.1070000 01	·		

				* 4 4 4 4 4 4	***	******	***** Ft ASFIC	STRAIMS ####	*****	********	マバチ マネギ ちかき かかっか
		*** THERMAL		***	***** I VIC 9	EMENTAL ***	はみみぞれをおす よまなかれ	本本本式 立れい ていぶ	*** CUMULAT	1V= *=***	
NU.		INCREMENTAL	CUMULATIV	/E XX	YY	77 .	XY	XX	YY	77	XY
1		0.15000.01	0.0	2							
- 2		-0.1500E 01					00 0.3050E-06				00 -0.2731F-07
3	_	0.0	_ 0.0	0.5000E	00 -0.25005	00 -0.25005	00 -0 -55665-0	7 0.1000F 01	-0.5000F 00	-0.50005 (00 0.3316E-06
4		0.0	0.0	0.50005	00 -0 75005	00 -0.2500F	00 -0.46535-05	-0.5000F 00	0.25001 00	0.2500E 4	30 -0.5136F-0T
			V •0	Q# 2000E	00 -0-2-00-	00 -0.2500F	00 0.20865-06	-0.5000E 00	0.25008 00	3.2500E	10 0.352°F-07
			<u> </u>								
				***	*****	* * * * * * * * * * * * * * * * * * * *	OLISATA PERSON	STRAINS ## **	点类出现解析表表更换要素	ararakstata	* * * * * * * * * * * * * * * *
		**** PLASTI		(字 学术学术主教会	***** 1 NER	EMENTAL ***	(我教授教教育专作者教授双示	**********	### CHMULAT	TUE TRANS	· · · · · · · · · · · · · · · · · · ·
NO I	Đ.	INCREMENTAL	CUMULATIV	E XX	YY	77.	XY	XX	YY	7.7	XY
		0.5000E 00			00 -0.2500F	00 -0.2500F	00 -0.21716-07		-0.5000F 00	-0.5000E	00 -0.7783E+07
		0.50 CCF 00		0.5000F	00 -0.2500E	00 -0.2500F	00 0.55385-0		-0.5000E 00	-0.50000	00 0.1453F-06
3		0.0	0.1500E 0		0,0	<u>0.1</u>	0.0				00 0.6173F-07
4	12	0.0	0.1500E 0	01 0.0	0.0	0.0	O. O	-0.1500F 01	0.7500E OD	0.75006	00 -0.18446-06
						·					
				****	*****	****	IMILATIVE STRE	SS DIMETITIES	*****		
EL EME	NT	EFFECTIVE	FFFECTIVE	****	*** ** STRES	S CENTER ###	古年の女性政治の大力を	********	23917 ****	C #######	* 注: 全古太家出表六五元五
NO. I	. D.	CENTER	STRESS	XX	_YY	Z7	XY	XX	Y.V	7.7	XY
									· · · ·		
1	1	0.0	0.1000E 0	1 0.0	0.0	0.0		0.1000E 01	0.25046-06	2.0	-0.1821F-07
2		0.0	0.1000E 0		. 0.0	0.3	0.0	0.1000E 01	0.179°E-06	7.0	0.2210E-06
<u>3</u>	. 11		0.5000E 0		0.0	<u> </u>	0.0	-0.5000F 00	-0.2583E-07	0-0	-0.3457E-07
4	12	0.0	0.5000E 0	0.0	0.0	0+0	0.0	-0.5000E 00	0.2583E-07	.0.0	0.2359E-07
											
ELEME	NT	E-P SUM IN	ICREMENTAL	TOTAL	SURFACE	*AXX DEFECT	TVE PLASTIC ST	DAIMC PER #		UE COUED 53	Tr. 4 1310
NO. I	Đ.	CODE CODE TE	MPERATURE		YIELD SIZE	INCREMONTAL	SUM TWOR. CI	IMULATIVE IN	CPEMENTAL S	AK INCE (
<u></u>			1500F 01	0.0	0.10005 01		0.10005 01		0.0	<u>0.0</u>	0.0
2	. 2		1500E C1	0.0	0.1000= 01		0.1000F 01			0.0	0.0
	-!1_			0.0	0.1000E 01	0.0	0.1500F 01) <u>, ′)</u>	0.0
4	12	-1 -2 0	la U .	0.0	0.1000E 01	0.0	0.1500E OI	0.1500F 01	0.0	0.0	0.0
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INCREMENT 6 (HDT)	NO Z-LOADS FOR LOAD INCREMENT 6	
ELEMENT I.D. 1 2 11	17	
TEMP. 0.15000F 01 0.15000F 01 0.0 Z-LOAD 0.0 0.0 0.0	0.0 0.0	
ITERATIVE ERROR = 0.12500E 01 ITERATIVE ERROR = 0.39608E-05		
ITERATIVE ERROR = 0.14142E 00		
ITERATIVE ERROR = 0.14143E 00		
ITERATIVE ERROR = 0.14143E 00 ITERATIVE ERROR = 0.12657E+05		•
ITERATIVE ERROR = 0.19410E-05		
NAME OF TAXABLE PARTY.		<u> </u>
ENDUFLO	A D INCREMENT A	
INCREMENT 6 (HOT)		
MECHANICAL LOAD CURVE FACTORS = 0.1000E 01.	0.0	
<pre>CREEP TIME INCREMENT = 0.0 NO. ELASTIC ELEMENTS = 2. NO. PLASTIC ELEM</pre>	MTC - 2	
		•
	C+ 2 ELEMENTS PLASTIC TO ELASTIC DURING THIS T	NCREMENT
SPECIFIED MAX. NO. STIFFNESS UPDATES = 2.	C+ 2 ELEMENTS PLASTIC TO ELASTIC DURING THIS T NO. UPDATES PERFORMED = 0	
SPECIFIED MAX. NO. STIFFNESS UPDATES = 2. SPECIFIED MAX. NO. ITERATIONS PER UPDATE =	NO. UPPATES PERFORMED = 0 10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE =	NCREMENT .
SPECIFIED MAX. NO. STIFFNESS UPDATES = 2. SPECIFIED MAX. NO. ITERATIONS PER UPDATE =	NO. UPPATES PERFORMED = 0 10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE =	
SPECIFIED MAX. NO. STIFFNESS UPDATES = 2. SPECIFIED MAX. NO. ITERATIONS PER UPDATE =	NO. UPPATES PERFORMED = 0 10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE =	
SPECIFIED MAX. NO. STIFFNESS UPDATES = 2. SPECIFIED MAX. NO. ITERATIONS PER UPDATE =	NO. UPPATES PERFORMED = 0 10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE =	
SPECIFIED MAX. NO. STIFFNESS UPDATES = 2. SPECIFIED MAX. NO. ITERATIONS PER UPDATE =	NO. UPPATES PERFORMED = 0 10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE =	
SPECIFIED MAX. NO. STIFFNESS UPDATES = 2. SPECIFIED MAX. NO. ITERATIONS PER UPDATE =	NO. UPPATES PERFORMED = 0 10, NO. ITERATIONS PERFORMED SINCE LAST UPDATE =	
SPECIFIED MAX. NO. STIFFNESS UPDATES = 2. SPECIFIED MAX. NO. ITERATIONS PER UPDATE = SPECIFIED MAX. UNBALANCED-FORCE ERROR = 0.10 ******* CUMULATIVE INTERNAL FO	NO. UPDATES PERFORMED = 0 10, NO. ITERATIONS PEPFORMED SINCE LAST UPDATE = 0E-04, ACTUAL FEROR = 0.1941F-05 CES AND DISPLACEMENTS *******	
SPECIFIED MAX. NO. STIFFNESS UPDATES = 2. SPECIFIED MAX. NO. ITERATIONS PER UPDATE = SPECIFIED MAX. UNBALANCED-FORCE ERROR = 0.10 ******** CUMULATIVE INTERNAL FO *** NODE ** *********************************	NO. UPDATES PERFORMED = 0 10, NO. ITERATIONS PEPFORMED SINCE LAST UPDATE = 0E-04, ACTUAL FEROR = 0.1941F-05 CES AND DISPLACEMENTS ****** ***** DISPLACEMENTS *******	
SPECIFIED MAX. NO. STIFFNESS UPDATES = 2. SPECIFIED MAX. NO. ITERATIONS PER UPDATE = SPECIFIED MAX. UNBALANCED-FORCE ERROR = 0.10 ******** CUMULATIVE INTERNAL FO *** NODE ** *********************************	NO. UPDATES PERFORMED = 0 10, NO. ITERATIONS PEPFORMED SINCE LAST UPDATE = 0E-04, ACTUAL FEROR = 0.1941F-05 CES AND DISPLACEMENTS *******	
SPECIFIED MAX. NO. STIFFNESS UPDATES = 2. SPECIFIED MAX. NO. ITERATIONS PER UPDATE = SPECIFIED MAX. UNBALANCED-FORCE ERROR = 0.10 ******** CUMULATIVE INTERNAL FO. ** NODE ** *********************************	NO. UPDATES PERFORMED = 0 10. NO. ITERATIONS PEPFORMED SINCE LAST UPDATE = 0E-04. ACTUAL FEROR = 0.1941F-05 CES AND DISPLACEMENTS ****** ****** DISPLACEMENTS ****** U 0.0 0.0 0.0	
****** CUMULATIVE INTERNAL FOR ID. U. V. V	NO. UPDATES PERFORMED = 0 10. NO. ITERATIONS PEPFORMED SINCE LAST UPDATE = 0E-04. ACTUAL FEROR = 0.1941F-05 CES AND DISPLACEMENTS ****** ***** DISPLACEMENTS ****** U 0.0 0.0 0.7499990F (0)	
\$PECIFIED MAX. NO. STIFFNESS UPDATES = 2. \$PECIFIED MAX. NO. ITERATIONS PER UPDATE = \$PECIFIED MAX. UNBALANCED-FORCE ERROR = 0.10 **********************************	NO. UPPATES PERFORMED = 0 10, NO. ITERATIONS PEPFORMED SINCE LAST UPDATE = 0E-04, ACTUAL FEROR = 0.1941F-05 CES AND DISPLACEMENTS ****** ***** DISPLACEMENTS ****** U 0.0 0.0 0.7499990F (0 0.3000000E 0: -0.5009626E-06	
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1.1

9.3 STAINLESS STEEL HYSTERESIS LOOPS

This example is intended to aid the user in reducing cyclic test data into a form suitable for BOPACE input. The stainless steel specimen used in the example exhibits a pronounced variation in isotropic and kinematic hardening as the cycling progresses, and thus provides a severe test of the BOPACE capability for combined hardening.

The cyclic test data are shown in Figure 9.3-1 by the solid lines.* The plotted points and dashed lines represent the analytical results obtained from a BOPACE run. The hysteresis loops are denoted by dash numbers, with the first number denoting the cycle number and the second denoting the lst and 2nd half of the cycle.

Because of the obvious variation in magnitude of kinematic hardening over the test cycles, the BOPACE option for variable kinematic hardening was employed in addition to the usual combined isotropic and kinematic hardening. The assumed hardening curves are given in Figure 9.3-2, and the BOPACE input data are listed at the end of this section. A summary of the analytical results is shown in Table 9.3-1.

The itest/analysis correlation is quite good, and could be further improved if one were willing to accept some amount of non-smoothness in the input hardening curves of Figure 9.3-2. An exact match would require hardening curves with discontinuous slopes at points corresponding to the strain

* The test hysteresis loops were furnished by Dr. R. H. Mallett of the Advanced Reactor Division, Westinghouse Electric Corp.

9.3 (Continued)

range used in the cyclic test. This is not justifiable in general, because a proper test/analysis match would not result for other strain ranges. Although the test/analysis correlation is considered to be very satisfactory, cyclic results for other strain ranges would have to be compared before any definite conclusions can be drawn.

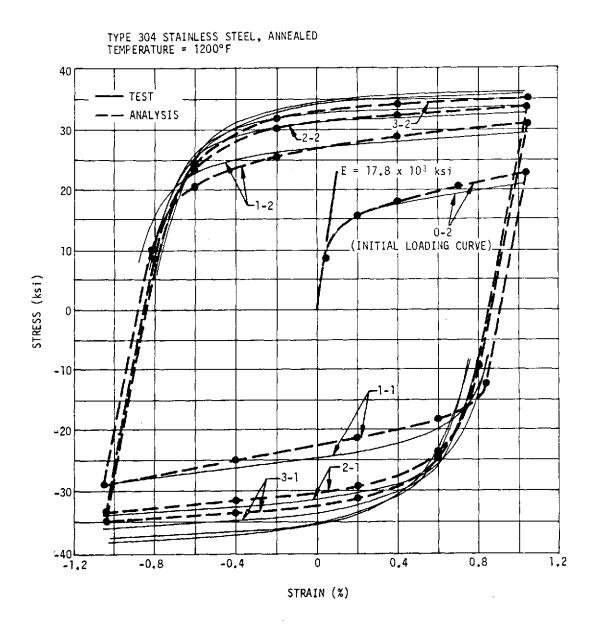


FIGURE 9.3-1: CYCLIC TEST/ANALYSIS CORRELATION FOR STAINLESS STEEL

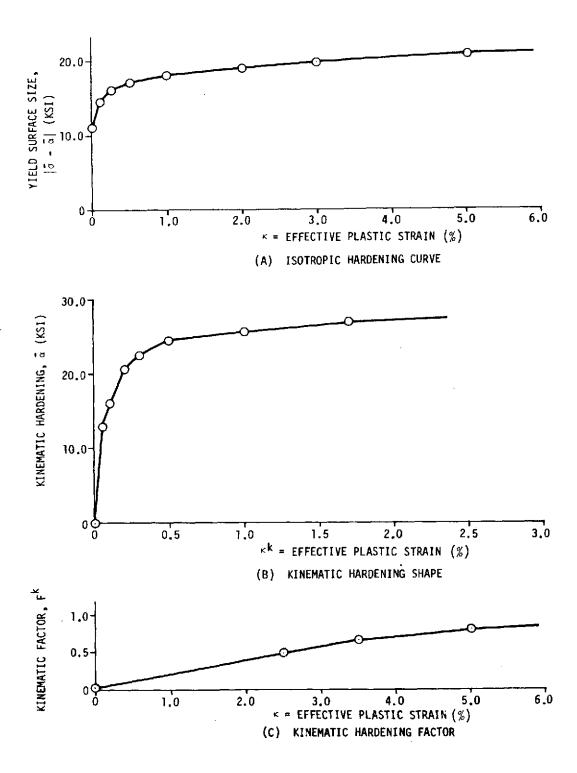


FIGURE 9.3-2: STAINLESS STEEL HARDENING ASSUMPTIONS

TABLE 9.3-1: RESULTS FOR STAINLESS STEEL HARDENING

INCR.	CYCLE	DISPLACEMENT	$\frac{3}{2}$ αXX	σχχ	$ \bar{\sigma} - \bar{\alpha} $	ITERATIONS
1 2 3 4 5	0-2 0-2 0-2 0-2 0-2	.05 .2 .4 .7 1.04	0.00 0.70 1.74 3.27 4.97	8.90 15.33 17.94 20.44 22.80	11.00 14.64 · 16.20 17.17 17.82	1 13 8 7 7
6 7 8 9 10	1-1 1-1 1-1 1-1 1-1	.9 .8 .6 .2 4 -1.04	4.97 3.38 0.10 -2.66 -5.95 -9.48	-2.12 -14.50 -18.02 -21.17 -25.01 -28.97	17.82 17.88 18.12 18.50 19.06 19.49	1 9 8 7 7 7
12 13 14 15 16	1-2 1-2 1-2 1-2 1-2 1-2	9 8 6 2 .4	-9.48 -7.84 1.05 5.89 8.59 10.83	-4.05 11.65 20.65 25.69 28.70 31.25	19.49 19.50 19.60 19.82 20.11 20.42	1 7 9 8 7 7
18 19 20 21 22 23	2-1 2-1 2-1 2-1 2-1 2-1	.9 .8 .6 .2 4 -1.04	10.83 9.85 -2.58 -8.64 -10.54 -12.34	6.33 -10.57 -23.07 -29.31 -31.43 -33.45	20.42 20.42 20.49 20.67 20.89 21.11	1 7 9 8 7 7
24 25 26 27 28 29	2-2 2-2 2-2 2-2 2-2 2-2	9 8 6 2 .4 1.04	-12.34 -12.06 2.28 9.10 11.00 12.35	-8.53 9.05 23.43 30.38 32.46 33.97	21.11 21.11 21.15 21.27 21.46 21.63	1 5 10 7 7 7
30 31 32 33 34 35	3-1 3-1 3-1 3-1 3-1	.9 .8 .6 .2 4 -1.04	12.35 12.35 -2.80 -9.98 -11.71 -13.09	9.06 -8.74 -24.45 -31.73 -33.62 -35.17	21.63 21.63 21.66 21.76 21.91 22.08	1 11 8 7 7
36 37 38 39 40 41	3-2 3-2 3-2 3-2 3-2 3-2	9 8 6 2 .4 1.04	-13.09 -13.09 2.25 9.83 11.49 12.70	-10.25 7.55 24.36 32.03 33.79 35.10	22.08 22.08 22.11 22.20 22.30 22.40	1 12 8 7 7

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CYCLF 2-1	
CYCLE 2-1	D5 ·
CYCLE 2-1	
CYCLE 2-1	2
CYCLF 2-1	
CYCLE 2-1	TIP
CYCLF 2+2	
CYCLF 2-2	
CYCLE 2-2	
CYCLE 2-2	
CYCLE 2-2	
CYCLE 2-2	

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D5-17266-2

9.4 TYPICAL ENGINE ANALYSIS

The BOPACE program has been directed toward thermo-structural analysis of thrust chamber liners in the Space Shuttle Main Engine (SSME) and in other scale model engines. This section describes a typical analysis for the SSME.

Figure 9.4-1 shows a cross section of the SSME 470K thrust chamber. For the present demonstration a generalized plane-strain analysis is performed for a radial segment at a station 25.4 mm (1.0 inch) upstream of the throat. Details of this segment are given in Figure 9.4-2. The finite element model is shown in Figure 9.4-3. Because this is a demonstration problem and because several loading cycles are analyzed, the selected mesh is fairly crude (only about 250 degrees of freedom). However the results appear to be quite good and indicate that a very fine mesh may not be needed for this type of analysis.

The demonstration problem is summarized as follows.

- Three cycles at the given station in the SSME 470K engine are analyzed.
- Each cycle is defined by a start transient, sustained burn and shutdown. Sustained burn will last 500 seconds and shutdown is defined in the detailed report of the demonstration problem (Document D5-17266-3).
- 3. For demonstration purposes, the following are included.

9.4 (Continued)

- a. Creep behavior based on Boeing test data for NARLOY-Z.
- b. Estimated cyclic behavior of NARLOY-Z.
- c. Specified variation of z-strain from the inside of the liner to the outside of the structural jacket.
- d. Local tangential slip is allowed between the liner and Inconel jacket.

A listing of the input data is included at the end of this section. In order to avoid unnecessary duplication, the listing includes thermal and z-load data for only the 1st increment (involving only thermal loads) and the 5th increment (involving both thermal and imposed z-strain loads).

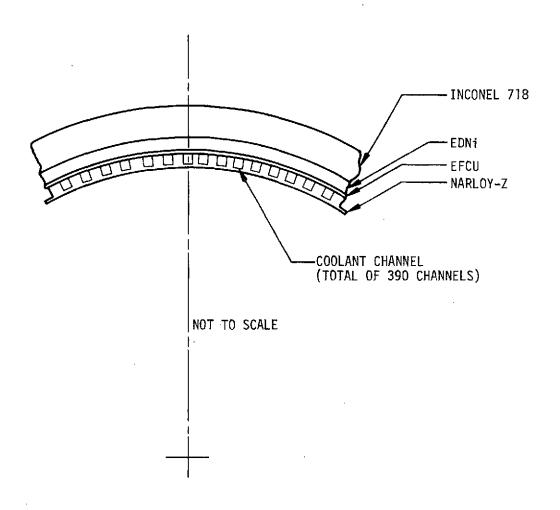


FIGURE 9.4-1: SSME 470K THRUST CHAMBER CROSS SECTION

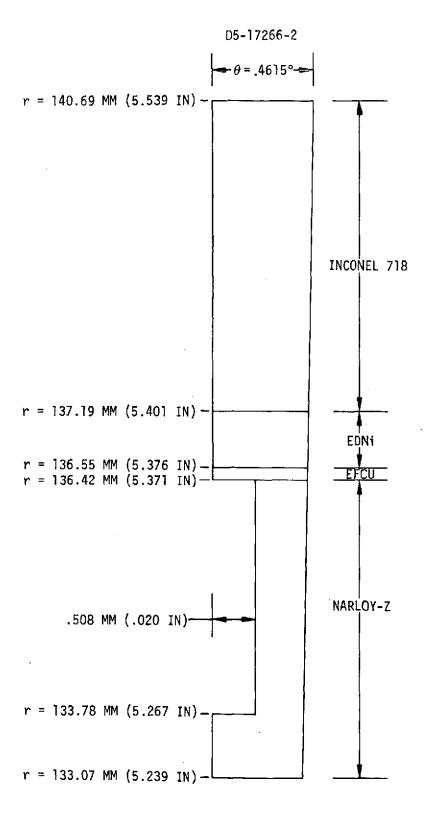


FIGURE 9.4-2: THRUST CHAMBER SEGMENT FOR ANALYSIS

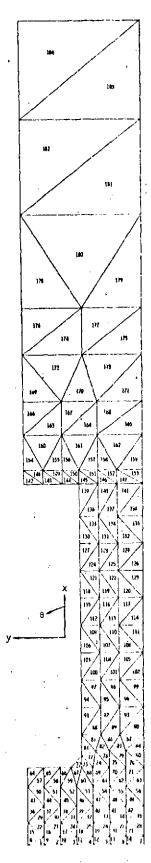


FIGURE 9.4-3: FINITE ELEMENT MODEL

START SSME DEM	5 ONSTRATION 4 1.0	5 6 I PROBLEM FI 255.	0 0 OR NAS8+29	22 9821 INCREM	ENTS 1-20			START/RESTART CODE AND DATA FILE NUMBERS PROBLEM I.D. TITLE PROGRAM CONTROL CONSTANTS (BLANK CARD) PLANE STRAIN, 4 MATERIALS, DEFAULT THICK., FAB. TEMP.
33.15 922.	1 0038 -0122	255.4	0.	477.6	.0038	699.8	_0078	
33.15 922.		+3 255.4 +3	1 30. 3	+3 477.6	117,2	+3 699.8	108.2	+3 MATERIAL PROPERTY DATA (NARLOY-Z)
33.15	+33	922.	. 33					··
` - 2	2	• • •	001.	201	2212	.70	2020	Ħ
` 33.	-,0022	144.	0014	294.	.0018	478.	.0038	MATERIAL PROPERTY DATA
33.	147.	+3 144.	139.	+3 294.	130.	+3 478.	121-	+3 (EFCU)
33.	.36	478.	. 26					
144.	3 002	294.	. 8004					7
144.		+3 294	191.	+3				MATERIAL PROPERTY DATA
144,	.34			*3	•			(EDNi)
1444		294.	. 34					=
144-	001	294.	.0006					·
o 144.	207.	+3 294.	207.	+3				MATERIAL PROPERTY DATA (INCONEL 718)
A 144.	. 315	294.	. 293					
	1	, 1	1					4
0. .0283	1 33. 172.4 187.5	.00365 .0481	174.4 199.	.00853	176.5 199.	.00184 .10	182. 199.	
0. .0283	0. 60. 7	.00365 .0481	43.1 67.2	.00853 .07	53. 1 72. 4	. 01 84 . 10	57.6 79.3	
· 0. • 0283	.23 .887	.00365 .0481	.432 1.0	.00853 .07	.636 1.0	- 01 84 - 10	. 79 1.0	
0. .0293	1 294. 137.9 146.2	.00368 .0482	139.3 151.3	.00853 .0680	141. 151.7	.0184 .10	143.4 151.7	
0. .0283	0. 87.6	.00368 .0482	63.8 96.5	.00853 .0680	78.6 106.2	.0194 .10	82.7 113.8	
0. .0283	. 4	.00368 .0482	.465 .88	.00853 .068	.60 1.0	.0184 .10	.685 1.0	
0. .02847	1 700. 106.9 113.2	.00381	107.8 117.1	.00970 .0683	109. 117. 6	.01855	111. 117.6	
0.	0.	.00381	38.6	.00870	49.2	.01855	50.3	

													1
	.02847		53.1		.04837	59.98	•	0683	63.79	-10	66.98	!	,
9.4-7	0. .02847		. 45 .98		.00381	• 55 • 99		00870 0683	•695 1. 0	.01855. .10	,90 1. 0		
	0. .02851	1	811. 80.7 85.4		.00383	81.3 88.3		00866	82.1 88.8	.01858	83.7 88.8		
	0. .02851		0. 33.09		.00383	24.13 37.58		00866 07	29,44 38,82	.01858	32.06 39.		
	0. .02851		.22 .96		.00383	.52 1.0		00855 07	.845 1.0	.01858	.94 1.0		
	0. .02857	1	922. 44.8 47.4		.00395	45.3 49.0		008 83 068 52	45.5 49.3	.01868	46.5 49.3		
	0. .02857		0. 33.23		.00395 .04853	21. 24 33.78		008 83 068 52	24.82 34.13	.01868 .10	29.37 34.13		į
	0. .02857		.5 1.0		.00395	. 66 1.0		00893 06852	• 83 1- 0	.01868	.95 1.0		
	0.	2	33. 62.1	1	.10	62.1						. =	
	0. .0189		0. 103.4		.0011	68.9 137.9		004 0685	81.4 162.0	.00895 .10	92.4 163.0		
	0.	2	144. 48.3		.10	48.3							
	0. .019		0. 91.0		.00121	62.1 119.3		00413 0687	73.1 137. 9	.00906 .10	82.0 140.		PLASTICITY DATA
	0.	2	294. 41.4		.10	41-4							(EFCu)
	0. .0192		0. 68.9		.00133	44.8 91.		00425 0689	55.2 106.2	.0092 .10	62.1 107.		
	0.	2	478. 34.5		.10	34.5							
	0. .0194		0. 34.5		.00157	17.9 44.1		00451 0693	25.5 49.6	-00946 -10	31. 50.		
		3	144.	1		0						-]
	0.	2	310.		.10	310.							
	0. .0469		0. 262.		.0028	103. 262.	4	0075	155.	.0271	224.		PLASTICITY DATA (EDNi)
		3	294.										

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0.
             276.
                        .10
                                  276.
             0.
                        .0029
                                  103.
                                             .007B
                                                       138.
                                                                 .0274
                                                                           193.
   .0473
             214.
                       .10
                                  214.
           4 294.
   0.
             827.
                        .10
                                  827.
                                                                                         PLASTICITY DATA
   0.
             Q.
                       .0013
                                  138.
                                            .0048
                                                       248.
                                                                 .0145
                                                                           317.
                                                                                          (INCONEL 718)
   .0441
             386.
                       .10
                                  400.
           1
 0.0
            0.0
                      20.
                                 .00008
                                           60.
                                                      .00020
                                                                180.
                                                                          .00029
            .00043
 600.
                      1200.
                                 .00054
                                           1800.
                                                      .00064
                                                                3600.
                                                                          .00075
           1 644.0
                      97.0
 0.0
            0.0
                                 0.0
                                                                207.0
                                           138, 6
                                                      0.0
                                                                          0.0
                                                                                         CREEP DATA
           1 811.0
                                                                                         (NARLOY-Z)
 0.0
            0.0
                       97.0
                                 1.0
                                           138.0
                                                     2.0
                                                                207.0
                                                                          5.0
           1 922.0
 0.0
            0.0
                      97.0
                                 2.0
                                           138.0
                                                                207.0
                                                      6.0
                                                                          20.0
           2
                     2
φ 3600.
            0.0
           2 922.0
                                                                                         CREEP DATA
 207.0
            0.0
                                                                                           (EFCu)
                     2
 3600.
            0.0
                                                                                         CREEP DATA
           3 922.0
 207.0
            0.0
                                                                                           (EDNi)
                     2
  3600.
            0.0
           4 922.0
                                                                                          CREEP DATA
 207.0
                                                                                         (INCONEL 718)
            0.0
                                                                                      →SPECIAL COORDINATE SYSTEMS (BLANK CARD)
           0 133.07054
           0 133-07054
                       -0.15240
      3
           0 133.07054 -0.30480
           0 133.07054 -0.45720
           0 133.07054
                       -0.60960
           0 133.07054
                        -0.76200
           0 133.07054
                        -0.91440
           0 133.06621 -1.07192
      8
           0 133.14674
                        0.0
           0 133.14674 -0.15240
```

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```
11
      0 133.14674 -0.30480
      0 133,14674
                   -0.45720
12
      0 133.14674
                   -0.60960
13
      0 133.14674
                   -0.76200
14
15
      0 133.14674
                   -0.91440
16
      0 133.14241
                   -1.07254
17
      0 133.27376
                    0.0
      0 133.27376
                   -0-15240
18
19
      0 133,27376
                   -0.30480
20
      0 133.27376
                   -0.45720
21
      0 133.27376
                   -0.60960
22
      0 133.27376
                   -0.76200
                   -0.91440
23
      D 133, 27376
                   -1.07356
24
      0 133,25942
25
      0 133,42615
                    0.0
      0 133.42615
                   -0.15240
26
27
      0 133.42615
                   -0.30480
      0 133,42615 -0,45720
28
      0 133.42615 -0.60960
29
30
      0 133.42615 -0.76200
      0 133.42615 -0.91440
31
32
      0 133,42181
                    -1.07479
33
      0 133,60394
                    0.0
34
      0 133,60394
                   -0.15240
      0 133.60394
                   -0.30480
35
36
      0 133,60394
                   -0.45720
37
      0 133,60394
                    -0.60960
38
      0 133,60394
                   -0.76200
39
      0 133,60394
                   -0.91440
                   -1.07622
      0 133,59961
41
      0 133, 78174
                    0.0
42
      0 133,78174
                   -0.15240
43
      0 133.78174
                   -0.30480
44
      0 133.78174 -0.40640
                   -0.50800
45
      0 133.78174
46
      0 133.78174
                   -0.60960
47
      0 133,78174 -0.76200
      0 133.78174
                   -0.91440
48
      0 133,77737 -1,07765
49
      0 133.88336 -0.50800
50
      0 133.93416 -0.63500
51
                                1
1
1
1
1
1
52
      0 133.93416 -0.76200
53
      0 133,93416
                   -0.91440
54
      0 133.92979
                   -1.07888
55
      0 134.08655
                   -0.50800
      0 134.08655
                   -0.68580
56
57
      0 134.08655
                   -0.86360
        134.08218
                   -1.08011
58
      0 134.34055
                   -0.50800
59
                   -0.68580
60
      0 134,34055
      0 134.34055
                   -0.86360
61
      0 134.33618
                   -1.08215
62
63
      0 134,59456
                   -0.50800
64
      0 134,59456
                   -0.68580
      0 134.59456 -0.86360
65
66
      0 134.59016
                   -1.08420
67
      0 134.84854
                   -0.50900
                                ı
      0 134.84854
                  -0.68580
      0 134.84854 -0.86360
69
      0 134.84415 -1.08624
```

-NODE DEFINITIONS

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05-17266-2
```

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71
       0 135.10254 -0.50800
       0 135, 10254
 72
                    -0,68580
                    -0.86360
 73
       0 135.10254
 74
       0 135.09816
                    -1.08829
 75
       0 135.35655
                    -0.50800
 76
       0 135.35655
                    -0.68580
 77
       0 135,35655
                    -0.86360
 78
       0 135.35214
                    -1.09034
 79
       0 135.61055
                    -0.50800
 80
       0 135,61055
                    -0.68580
 81
       0 135.61055
                    -0.86360
 82
       0 135.60614
                    -1.09238
 83
       0 135.86456
                    -0.50900
 84
       0 135 86456
                    -0.69580
 85
       0 135.86456
                    -0.86360
       0 135.86015 -1.09443
 86
       0 136,11855 -0.50800
 37
 88
       0 136.11855 -0.68580
 89
       0 136.11855 -0.86360
 90
       0 136.11411 -1.09648
 91
       0 136.42334
                     0.0
 92
       0 136.42334
                    -0.17780
 93
       0 136.42334
                    -0.35560
 94
       0 136.42334
                    -0.50800
 95
       0 136,42334
                    -0,68580
 96
       0 136.42334
                    -0.86360
 97
                    -1.09893
       0 136.41891
 98
       0 136.55034
                     0.0
 99
       0 136.55034
                    -0.17780
100
       0 136.55034
                    -0.35560
101
       0 136.55034
                    -0.50800
102
       0 136,55034
                    -0.68580
103
       0 136.55034
                    -0.86360
104
       0 136.54591
                    -1.09995
105
       0 136.88055
                     0.0
106
       0 136.88055
                    -0.35560
107
       0 136.88055
                    -0.68580
       0 136,87610
                    -1.10261
108
       0 137.18533
109
                     0.0
110
       0 137.18533
                   -0.35560
111
       0 137.18533 -0.68580
210
       0 137.18533
                    -0.35560
211
       0 137.18533
                   -0.68580
112
       0 137.18088 -1.10507
113
       0 137 61714
                    0.0
       0 137.61714
114
                    -0.55880
115
       0 137.61266
                    -1.10855
116
       0 138.04895
                     0.0
117
       0 138.04895
                    -0.55880
       0 138.04446
                    -1.11203
118
119
       0 138.91255
                     0.0
       0 138.90805
120
                    -1.11898
121
       0 139,77614
                     0,0
122
       0 139.77159
                    -1.12594
123
       0 140 69055
                     0.0
124
       0 140.68597
                    -1.13330
  1 2 3
       1
                       2
                           10
                                 ı
                          11
       1
                       3
                                 2
                                 3
```

4	1	5	1.3	4
5	ī	6	1.6	5
			17	
6	1	7	14 15 16	5 6 7
7	1	8	16	7
8	1	9	1	10
9	ī			11
9		10	2	11
10	1	11	· 3	12 13
1.1	1	12	4	1.3
1 2	ī	12	5	14
11 12 13 14		13 14 15 17	,	17
13	1	14	6 7	15 16
14	1	15	7	16
15 16	1	17	9	10 11
1.4	ī	18	1ó	11
			10	11
17	1	19	11	12
18 19	1	20 21 22 23	12	13
10	1	21	13	14
20		22	14	15 16 17
20	1	22	14	15
21	1	23	15 18	16
22	i	10	18	17
22	ī		19	1.0
23	1	11 12	1,7	1.0
23 24	1	12	20	19
25 26	1	13	21	18 19 20 21 22 23
26	1	1.4	- 22	21
27		14 15 16	23	
27 28	1	15	23	22
28	1	16	24	23
29	1	18	26	17
30	ī	19	27	18
30	:	17	2,	10
31 32	1	20 21	28	19 20
32	1	21	29	20
33	1	22	30	21
34	i	23	31	22 23 26
2 4		23	31	22
35 36	1	24	32	23
36	1	25	17	26
37	1	25 26 27	18	27
38		27	19	70
30	. 1	21	19	27 28 29 30
39 40	1	28 29	20 21	29
40	1	29	21	30
41 42	ì	30	22	31 32 26 27 28 29
7.2	•	21	22 23 25 26	22
4.2	1	31 33 34	23	32
43	1	33	25	26
44	1	34	26	27
45	i	35	27	28
7.7		35 36 37 38	27 28 29 30	20
46 47	1	30	40	29
47	1	37	29	30 31 32
48 49	1	38	30	31
49	1	30	31	32
FO		39 26 27		22
50 51	1	20	34	33 34
51	1	27	35	34
52	1	28 29 30	36	35
5.3	1	29	37	36
		20	37 38	
52 53 54 55	1	30	36	35 36 37
55	1	31	39 40	38
56	1	32	40	39
57 58	í	31 32 34	42	38 39 33
-		25		34
מכ	1	35 35	43 36	24
59	ī	35	36	44
60	1	36	37	45
61	ī	38	47 48	45 37
		39		38
62	1		48	38
63	1	40	49	39

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	64	1		41	33	42
	65	1		42	34	43
	66	1		43	35	44
	67	1		45	44	36
	68	1		37	46	45
	69	1		46	37	47
	70	1		47	38	48
	71	1		48	39	49
	72	1		45	50	44
	73	i		50	45	46
	74	ĩ		46	47	51
	75	ī		52	47	48
	76	î		53	48	49
	77	î		46	51	50
	78	i		4.7	52	51
	79	i		47		51
	80	1		48	53	52
				49	54	53
	81	1		55	50	51
	82	1		51	52	56
	83	1		52	53	57
	84	1		54	58	53
	85	1		56	55	51
	86	1		57	56	52
	87	1		58	57	53
	88	1		56	60	55
	89	1		57	61	56
	90	1		58	62	57
	91	į		59	55	60
	92	1		60	56	61
~	93	1		61	57	62
9.4-12	94	i		63	59	60
72	95	i		64	60	61
	96	ì		65	61	62
	97	î		60	64	63
	98	. 1		61		64
	99	ì			65	
				62	66	65
	100	1		64	68	63
	101	1		65	69	64
	102	1		66	70	65
	103	1		67	63	68
	104	1		68	64	69
	105	1		69	65	70
	106	1		71	67	68
	107	1		72	68	69
	108	1		73	69	70
	109	1		68	72	71
	110	1		69	73	72
	111	1		70	74	73
	112	1		72	74 76	71
	113	1		73	77	72
	114	ī		74	78	73
	115	ì		75	71	76
	114	i		76	72	77
	116 117	ì		, ₀	73	78
	118	1		79	75	76
	110	ì		80	76	
	119 120 121					77
	120	1		81	77	78
	151	Ţ		76	80	79
	122 123	1		77	81	80
	123	1		78	9.2	81

--ELEMENT DEFINITIONS

	124	1	80	84	79
	125	ī	81	85	80
	124 125 126	ī	82	86	81
	127	1	83	79	84
	128	1	84	80	85
	129	1	85	81	86
	130 131	1	87	83	84
	131	1	88	84	85
	132	1	89	. 85	96
	133 134 135	1	84	88	87
	134	1	85	89	88
	135	1	86	90	89
	136	1	8.9	95	87
	137	1	P 9	96	88
	138	1	90	97	89
	139	1	94	87	95
	140	1	95	88	96
	141	1	96	89	97
	142	2	98	91	92
	143	2	99	92	93
	144	2	100	93	94
	145	2	101 102	94	95
	146	2	102	95 96	96 97
	147 148	2	103 92	99	98
	149	111222222222223333333333333333344	93	100	99
	150	2	94	101	100
	151	2	95	102	101
9	152	2	96	103	102
4	153	2	97	104	103
9.4-13	154	2	105	98	99
LU.	154 155	3	100	106	99
	156	3	106	100	101
	157	3	102	107	101
	158	3	102 107	102	103
	159	3	104	108	103
	160	3	106	105	99
	161	3	107	106	101
	162	3	108	107	103
	163	3	106	110	105
	164	3	107	111	106
	165	3	109	112	107
	166	3	109	105	110
	167	3	110	106	111
	168	3	111 113	107	112
	169	4	113	109	210
	170	4	210	111	114
	171	4	112	115	211
	172	4	114	113	210
	173	4	115 114	114 117	211
	174	4	114	117	113
	175	4	115	118	114
	176	4	116 117	113 114	117 118
	177 178	4	110	114	117
	179	4	119 118	116 120	117
	180	4	120	119	117
	191	4	150	122	119
	182	4	120 121 122	122 119	122
	183	4	122	124	121
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184
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       2 -124
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  5
      1 -1524
      1 .1524
       1 .1524
       I .0762
41
      1 - 0762
 42
      1 - 1524
 43
      1 - 127
 44
       1 -. 1016
 44
       2 -.0508
 50
      1 -- 0508
       2 -. 1524
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__MECHANICAL LOAD REFERENCE VECTORS

CONSTRAINED DEGREES

OF FREEDOM

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7-002/1-05
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55
      2 -. 2286
59
      2 - 254
63
      2 -.254
67
      2 -. 254
71
      2 -. 254
75
      2 -. 254
79
      2 ~. 254
83
      2 - 254
87
      2 - 2794
94
      1 .0762
94
      2 -. 1524
93
      1 .1651
92
      1 -1778
      1 .0889
     20
       - 31
                  1.
       - 31
                  1.
                             • 4
        . 43
                  1.38
                             . 5
        1.49
                  4.83
                             .45
        2.13
                   6, 89
                             .25
                  9.65
                             . 2
        2.98
       4.15
                  13,44
                             . 2
        5.32
                  17.23
                             . 2
        6,60
                   21.37
                             . 2
                                                                                        INCREMENTAL MECHANICAL LOAD
        8.31
                  26,89
                             .2
                                                                                          DATA (20 INCREMENTS)
                   32.41
                             . 2
        10.01
        11.93
                   38.61
                             . 2
                   41.13
                             • 2
        12.71
                             . 2
        12.71
                   41.13
                             .2
        12.71
                   41.13
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            257.65
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            257.61
                                 257.62
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            257,40
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            257.32
                                 257.45
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                                                       256.75
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                                 256+64
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     17
            256.68
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     37
            254.88
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                                 254,27
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                                                       254.00
     41
            254.41
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            253.67
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     61
            250.91
                           62
                                 250.76
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                                 250.93
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     65
            251.30
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            249.88
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     73
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            248.39
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     81
            245.36
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     85
            244.16
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                                                                             242,53
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9.4-15

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242.97

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243.31

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241.49

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242.04

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	93	242.34	94	239.87	95	240.37	٩٨	240.64		
	97	239.26	9.8	239,51	99	239.88	100	237,85		
	101	238.18	102	238.42	103	237.12	104	237.54	ELEMENT	
	105	237.75	106	236.03	107	236.40	108	235.60	TEMPERATURES STATEMENT	
	109	235.62	110	235.99	111	236.09 234.19	112 116	234.68 234.50	121 THOREIGH	
	113 117	234.93 234.67	114 118	235.11 233.47	115 119	233.76	120	233.91		
	121	233.22	152	233.43	123	233.58	124	232.63	•	
	125	232.82	126	232.97	127	232.30	128	232.55		
	129	232.69	130	231.92	131	232.10	132	232.24		
	133	231.79	134	231.92	135	232.24	136	231.44		
	137	231.60	138	231.93	139	231.17	140	231-44	•	
	141 145	231.61	142 146	229.86 231,27	143 147	230.27	144 148	230.61		
	149	230.97 230.42	150	230.73	151	231.08	152	231.30		
	153	231.51	154	230.08	155	230.48	156	230.70		
	157	230.97	158	231.12	159	231.39	160	230.38		
	161	230.83	162	231.17	163	230.54	164	230.84		
	165	231.09	166	230.48	167	230.76	168	230.96		
	159 173	230.65	170	230.80 230.79	171 175	230.95 230.84	172 176	230.75		
	177	230.86 230.82	174 178	230. 19	179	230.92	100	230.78		
	181	230.81	182	230.81	183	230.81	184	230.81		
									ELEMENT Z-STRAINS (1ST INCREMENT)	
		*****			****		******	310.84	!	
	1	310.94	2	310.97	3	310.91	4			
		310 76	4	31/1 70	7	311.79	Q.	309_31	i	
	5 9	310.76 309.27	6 10	310.79 309.24	7 11	311.78 309.11	8 12	309.31 308.96	D.5-	
9	5 9 I3	310.76 309.27 308.92	6 10 14	310.79 309.24 309.83	7 11 15	311.78 309.11 304.99	8 12 16	309.31 308.96 304.90	D5-17.	
9,4-1	9 13 17	309.27 308.92 304.66	10 14 18	309.24 309.83 304.48	11 15 19	309.11 304.99 304.26	12 16 20	308.96 304.90 304.14	D5-17266	
9,4-16	9 13 17 21	309.27 308.92 304.66 304.75	10 14 18 22	309.24 309.83 304.48 302.26	11 15 19 23	309.11 304.99 304.26 302.02	12 16 20 24	308.96 304.90 304.14 301.70	D5-17266-2	
9,4-16	9 13 17 21 25	309.27 308.92 304.66 304.75 301.50	10 14 18 22 26	309.24 309.83 304.48 302.26 301.28	11 15 19 23 27	309.11 304.99 304.26 302.02 300.93	12 16 20 24 28	308.96 304.90 304.14 301.70 301.54	D5-17266-2	
9,4-16	9 13 17 21 25 29	309.27 308.92 304.66 304.75 301.50 296.28	10 14 18 22 26 30	309.24 309.83 304.48 302.26 301.28 295.86	11 15 19 23 27 31	309.11 304.99 304.26 302.02 300.93 295.39	12 16 20 24 28 32	308.96 304.90 304.14 301.70 301.54 295.03	D5-17266-2	
9,4-16	9 13 17 21 25	309.27 308.92 304.66 304.75 301.50 296.28 294.60	10 14 18 22 26	309.24 309.83 304.48 302.26 301.28 295.86 294.01	11 15 19 23 27	309.11 304.99 304.26 302.02 300.93	12 16 20 24 28	308.96 304.90 304.14 301.70 301.54	D5-17266-2	
9,4-16	9 13 17 21 25 29 33	309.27 308.92 304.66 304.75 301.50 296.28	10 14 18 22 26 30 34	309.24 309.83 304.48 302.26 301.28 295.86	11 15 19 23 27 31 35	309.11 304.99 304.26 302.02 300.93 295.39	12 16 20 24 28 32 36 40	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02	D5-17266-2	
9,4-16	9 13 17 21 25 29 33 37 41 45	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98	10 14 18 22 26 30 34 38 42 46	309.24 309.83 304.48 302.26 301.28 295.96 294.01 292.20 289.34 263.78	11 15 19 23 27 31 35 39 43	309.11 304.99 304.26 302.02 300.93 295.39 293.55 291.70 286.61 283.39	12 16 20 24 28 32 36 40 44	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02 282.28	D5-17266-2	
9,4-16	9 13 17 21 25 29 33 37 41 45 49	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66	10 14 18 22 26 30 34 38 42 46	309.24 309.83 304.48 302.26 301.28 295.86 294.01 292.20 289.34 283.78 281.98	11 15 19 23 27 31 35 39 43 47 51	309.11 304.99 304.26 302.02 300.93 295.39 293.55 291.70 286.61 283.39 280.91	12 16 20 24 28 32 36 40 44 48 52	308.96 304.90 304.14 301.54 295.03 293.17 291.10 285.02 282.28 280.27	D5-17266-2	
9,4-16	9 13 17 21 25 29 33 37 41 45 49	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 279.40	10 14 18 22 26 30 34 38 42 46 50	309.24 309.83 304.48 302.26 301.28 295.86 294.01 292.20 289.34 283.78 281.98 278.63	11 15 19 23 27 31 35 39 43 47 51	309.11 304.99 304.26 302.02 300.93 295.39 293.55 291.70 286.61 283.39 280.91 277.59	12 16 20 24 28 32 36 40 44 48 52	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02 282.28 280.27 276.66	D5-17266-2	
9,4-16	9 13 17 21 25 29 33 37 41 45 49 53	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 279.40 274.39	10 14 18 22 26 30 34 38 42 46 50 54	309.24 309.83 304.48 302.26 301.28 295.86 294.01 292.20 289.84 283.78 281.98 278.53 272.10	11 15 19 23 27 31 35 39 43 47 51 55	309.11 304.99 304.26 302.02 300.93 295.39 293.55 291.70 286.61 293.39 280.91 277.59	12 16 20 24 28 32 36 40 44 48 52	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02 282.28 280.27 276.66 269.71	D5-17266-2	
9,4-16	9 13 17 25 29 33 37 41 45 49 53 57	309.27 308.92 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 279.40 274.39	10 14 18 22 26 30 34 38 42 46 50 54 58	309.24 309.83 304.48 302.26 301.28 295.86 294.01 292.20 289.94 283.78 281.98 278.63 278.63 278.63	11 15 19 23 27 31 35 39 43 47 51	309.11 304.99 304.26 302.02 300.93 295.39 293.55 291.70 286.61 283.39 280.91 277.59	12 16 20 24 28 32 36 40 44 48 52 56	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02 282.28 280.27 276.66	D5-17266-2	
9,4-16	9 13 17 21 25 29 33 37 41 45 49 53	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 279.40 274.39	10 14 18 22 26 30 34 38 42 46 50 54	309.24 309.83 304.48 302.26 301.28 295.86 294.01 292.20 289.34 283.78 278.53 272.10 268.12 266.92	11 15 19 23 27 31 35 43 47 55 59 63 67	309.11 304.99 304.26 302.02 300.93 295.39 293.55 291.70 286.61 283.39 280.91 277.59 270.91 266.85 264.74	12 16 20 24 28 36 40 44 52 56 60 68 72	308.96 304.90 304.14 301.54 295.03 293.17 291.10 285.02 282.28 280.27 276.66 269.71 272.61 263.09 255.05	D5-17266-2	
9,4-16	9 13 17 21 25 29 33 37 41 45 49 57 61 65 73	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 279.40 274.39 268.80 268.62 262.65	10 14 18 22 26 30 34 38 42 46 50 54 66 70 74	309.24 309.83 304.48 302.26 301.28 295.96 294.01 292.20 289.94 283.78 261.98 278.63 272.10 268.12 262.98 250.74	11 15 19 23 27 31 35 39 47 51 55 63 71 75	309.11 304.99 304.26 302.02 300.93 295.39 293.55 291.70 286.61 293.39 280.91 277.59 270.91 266.85 264.74 262.39 253.16	12 16 20 24 32 36 44 48 52 64 67 76	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02 282.28 280.27 276.66 269.71 272.61 263.09 255.05 251.79	D5-17266-2	
9.4-16	9 13 17 21 25 29 33 41 45 49 53 57 61 65 67 77	309.27 308.92 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 274.39 268.80 268.62 262.65 253.26	10 14 18 22 26 30 34 38 42 46 50 54 58 66 70 74	309.24 309.83 304.48 302.26 301.28 295.86 294.01 292.20 289.94 283.78 281.98 278.63 278.63 278.63 278.63 278.63 278.63 278.71 266.82 262.98 250.74	11 15 19 27 31 35 39 47 51 55 63 67 71 75	309.11 304.99 304.26 302.02 300.93 295.39 293.55 291.70 286.61 293.39 280.91 277.59 266.85 264.74 262.39 253.16	12 16 20 24 32 36 44 48 52 56 64 57 76 80	308.96 304.90 304.17 301.54 295.03 293.17 291.10 285.02 282.28 280.27 276.66 269.71 272.61 263.09 255.05 251.79 251.79	D5-17266-2	
9.4-16	9 13 17 21 25 29 33 37 41 45 49 53 57 61 65 69 73 77	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 279.40 274.39 268.62 262.65 253.26 246.89	10 14 18 22 26 30 34 38 46 50 54 58 66 70 74 78 82	309.24 309.83 304.48 302.26 301.28 295.96 294.01 292.20 289.34 281.98 278.53 272.10 266.92 262.98 250.74 243.39	11 15 19 23 21 35 33 47 55 59 67 71 75 83	309.11 304.99 304.26 302.02 300.93 295.39 293.55 291.70 280.91 277.59 270.91 264.74 262.39 253.16 247.70 237.54	12 16 20 24 32 36 44 48 56 68 77 76 84	308.96 304.90 304.14 301.54 295.03 293.17 291.10 285.02 282.28 280.27 276.66 269.71 272.61 263.09 255.05 251.79 246.91 238.21	D5-17266-2	
9,4-16	9 13 17 25 29 337 41 45 49 57 61 669 73 77 85	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 279.40 274.39 268.62 262.65 253.26 246.89 235.24	10 14 18 22 26 30 34 38 42 46 50 54 58 66 70 74	309.24 309.83 304.48 302.26 301.28 295.96 294.01 292.20 289.94 263.78 278.53 272.10 268.12 266.92 262.98 250.74 247.07 232.32	11 15 19 27 31 35 39 47 51 55 63 67 71 75	309.11 304.99 304.92 302.02 300.93 295.39 295.39 291.70 286.61 283.39 280.91 277.59 270.91 266.85 264.74 262.39 253.16 247.75 237.54	12 16 20 24 32 36 44 48 52 56 64 57 76 80	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02 282.28 280.27 276.66 269.71 272.61 263.09 255.05 251.79 246.91 238.21	D5-17266-2	
9,4-16	9 13 17 21 25 29 33 37 41 45 49 53 57 61 65 69 73 77	309.27 308.92 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 274.39 268.80 268.62 262.65 253.26 246.89 235.24	10 14 18 22 26 30 34 38 42 46 50 54 62 67 74 78 88	309.24 309.83 304.48 302.26 301.28 295.86 294.01 292.20 289.84 283.78 281.98 278.53 278.63 27	11 15 19 27 31 35 47 51 55 63 67 77 87 87 95	309.11 304.99 304.26 302.02 300.93 295.39 293.55 291.70 286.61 283.39 280.91 277.59 266.85 264.74 262.39 253.16 247.70 237.54 232.92 213.04	12 16 22 38 44 55 66 57 76 84 88 96	308.96 304.90 304.70 301.54 295.03 293.17 291.10 285.02 282.28 280.27 276.66 269.71 272.61 263.09 255.05 251.79 246.91 238.21 219.08 216.93 209.55	D5-17266-2	
9,4-16	9 13 17 21 22 33 37 45 45 53 65 67 78 85 89 97	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 279.40 274.39 268.62 262.65 253.26 246.89 235.24 229.41 222.18 218.93 201.34	10 14 18 22 30 34 38 46 50 54 56 70 74 86 99 98	309.24 309.83 304.48 302.26 301.28 295.86 294.01 292.20 283.78 281.98 278.53 272.10 266.92 262.98 250.74 247.07 236.39 232.32 224.44 203.65	11 15 19 227 31 359 447 559 667 77 87 1999 999	309.11 304.99 304.26 302.02 300.93 295.39 293.55 291.70 280.91 277.59 270.91 266.85 264.74 262.39 253.16 277.70 237.54 232.92 213.04 205.37	12 16 204 28 36 44 46 56 66 77 88 88 99 100	308.96 304.90 304.14 301.74 295.03 293.17 291.10 285.02 282.28 280.27 276.66 269.71 263.09 255.05 251.79 246.91 238.21 319.08 216.93 209.82	D5-17266-2	
9,4-16	9 13 17 25 29 337 41 45 45 45 45 66 77 85 93 101	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 279.40 274.39 268.80 268.62 262.65 253.26 246.89 235.24 229.41 222.18 218.93 201.34 195.90	10 14 18 22 26 30 34 42 46 50 58 62 67 74 88 90 94 98 102	309.24 309.83 304.48 302.26 301.28 295.96 294.01 292.20 289.34 283.78 278.53 272.10 268.12 266.92 262.98 250.74 247.07 236.39 224.44 204.46 203.63	11 15 19 27 31 35 47 55 66 71 75 87 99 99 103	309.11 304.99 304.20 300.93 295.39 295.35 291.70 286.61 283.39 280.91 277.59 270.91 266.85 264.74 262.39 252.16 247.75 232.92 213.04 207.78 207.78	12 16 20 24 28 32 40 44 48 55 64 67 76 98 88 92 90 90 104	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02 282.28 280.27 27.66 269.71 272.61 263.09 255.05 251.79 246.91 219.08 216.93 209.55 193.82 192.50	D5-17266-2	
9,4-16	9 13 17 21 25 29 337 41 45 49 57 61 669 73 77 815 93 101 105	309.27 308.92 304.66 304.75 301.50 296.28 294.76 290.53 284.98 281.66 279.40 274.39 268.80 262.65 253.26 246.89 235.24 229.41 222.18 210.93 201.34 195.90 193.84	10 14 18 22 26 30 34 34 46 50 58 66 74 78 88 94 94 94 91 106	309.24 309.83 304.48 302.26 301.28 295.96 294.01 292.20 289.94 283.78 261.98 272.10 268.12 262.98 250.74 247.07 236.39 232.4.44 204.46 203.65 197.42 184.34	11 15 19 27 31 339 47 55 63 67 75 83 95 95 90 107	309.11 304.99 304.202 300.93 295.39 293.55 291.70 286.61 293.39 280.91 277.59 270.91 266.85 264.74 262.39 253.16 247.70 237.54 237.54 237.54 237.54 237.54 237.54 237.54 237.54	12 16 20 24 32 34 44 52 56 64 57 76 96 104 108	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02 282.28 280.27 272.66 269.71 272.61 263.09 255.05 251.79 246.91 238.21 219.08 219.38 219.38 219.38 219.38 219.38 219.38		
9,4-16	9 13 17 25 29 337 45 45 45 45 65 67 77 81 89 97 101 109	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 274.39 268.80 268.62 262.65 253.26 246.89 235.24 229.41 222.18 218.93 201.34 195.90 193.84	10 14 18 22 26 30 34 38 42 46 50 54 56 70 78 82 94 98 102 110	309.24 309.83 304.48 301.28 295.96 294.01 292.20 289.94 283.78 281.98 278.53 278.63 27	11 15 19 23 27 31 35 43 47 55 55 63 67 71 75 87 95 90 107 111	309.11 304.99 304.20 300.93 295.39 295.35 291.70 286.61 283.39 280.91 277.59 270.91 266.85 264.74 262.39 252.16 247.75 232.92 213.04 207.78 207.78	12 16 20 24 32 36 44 52 56 64 52 76 88 88 90 100 108 112	308.96 304.90 304.70 301.54 295.03 293.17 295.02 282.28 280.27 276.66 269.71 272.61 263.09 255.05 251.79 255.05 251.79 219.82 193.82 192.59 193.82 197.59	ELEMENT_TEMPERATURES (STH_INCREMENT)	
9.4-16	9 13 17 21 25 29 337 41 45 49 57 61 669 73 77 815 93 101 105	309.27 308.92 304.66 304.75 301.50 296.28 294.76 290.53 284.98 281.66 279.40 274.39 268.80 262.65 253.26 246.89 235.24 229.41 222.18 210.93 201.34 195.90 193.84	10 14 18 22 26 30 34 34 46 50 58 66 74 78 88 94 94 94 91 106	309.24 309.83 304.48 302.26 301.28 295.96 294.01 292.20 289.94 283.78 261.98 272.10 268.12 262.98 250.74 247.07 236.39 232.4.44 204.46 203.65 197.42 184.34	11 15 19 27 31 35 47 51 59 63 77 79 87 99 107 111 115	309.11 304.99 304.20 300.93 295.39 293.55 291.70 286.61 293.39 287.59 270.91 266.85 264.74 252.16 247.75 237.92 213.04 207.73 186.60 195.05 173.17	12 16 20 24 28 32 36 44 48 52 60 64 87 76 88 92 90 104 108 112 112 1120	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02 282.28 280.27 276.66 269.71 272.61 263.09 255.05 251.79 246.91 2319.08 216.93 209.55 192.50 187.80 177.89 176.87 174.01	ELEMENT TEMPERATURES	
9.4-16	9 13 17 21 25 29 33 41 45 49 57 61 65 67 77 81 89 93 101 105 109 113 117	309.27 308.92 304.66 304.75 301.50 296.28 294.76 290.53 284.98 281.66 279.40 274.39 268.80 262.65 253.26 246.89 235.24 229.21 220.18 210.34 195.90 193.84 182.39 179.02 177.80 170.43	10 14 18 22 26 30 34 34 46 50 58 66 74 78 82 90 94 91 106 110 114 118 122	309.24 309.83 304.48 301.28 295.96 294.01 292.20 289.94 283.78 261.98 272.10 268.12 262.98 272.10 268.37 266.32 262.98 234.44 204.46 203.62 181.54 183.96 180.98 171.54	11 15 19 27 31 339 47 51 59 63 67 77 88 95 90 107 111 119 123	309.11 304.99 304.20 300.93 295.39 293.55 281.70 283.39 280.91 270.91 266.85 264.79 264.79 253.16 247.70 237.54 207.78 207.78 207.78 207.78 209.87 186.60 195.15 175.17 175.38	12 16 20 24 83 32 40 44 48 52 50 64 87 76 90 104 112 1120 124	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02 282.28 280.27 272.66 269.71 272.61 263.09 255.05 251.79 246.91 238.21 319.08 219.38 219.38 219.50 187.80 177.59 176.87 174.01 167.51	ELEMENT TEMPERATURES	
9.4-16	9 13 17 21 25 29 337 45 49 53 61 65 69 77 81 85 93 97 101 105 113 117 121	309.27 308.92 304.66 304.75 301.50 296.28 294.60 292.76 290.53 284.98 281.66 274.39 268.80 274.39 268.65 253.26 246.89 235.24 229.41 222.18 218.93 201.34 195.90 193.84 182.39 179.02 177.80 170.43 169.52	10 14 18 22 26 30 34 38 42 46 50 54 58 66 70 78 82 90 94 90 110 114 118 127	309.24 309.83 304.48 301.28 295.86 294.01 292.20 289.84 283.78 281.98 278.10 266.92 262.78 266.92 262.78 266.93 247.07 236.32 247.07 247.07 247.07 247.07 247.07 247.07 247.07 247.07	11 15 19 23 27 31 35 39 47 51 55 63 67 77 83 87 95 90 107 111 115 112 123	309.11 304.99 304.26 300.93 295.39 293.55 291.70 286.61 283.39 280.91 270.91 266.85 264.74 262.39 247.70 237.54 237.54 237.59 247.70 237.59 247.70 237.59 247.70 237.59 247.70 237.59 247.70 237.59 247.70 237.59 247.70 237.59 247.70 237.59 247.70 237.59 247.70 237.59 247.70 24	12 16 20 24 32 36 44 48 52 56 64 52 76 88 88 90 100 108 115 116 124 128	308.96 304.90 304.70 301.54 295.03 293.17 291.10 282.28 280.27 276.66 269.71 272.61 263.09 255.05 251.79 246.91 238.21 216.93 219.55 193.82 192.50 187.80 177.59 176.87 174.01 167.23	ELEMENT TEMPERATURES	
9,4-16	9 13 17 21 25 29 33 41 45 49 57 61 65 67 77 81 89 93 101 105 109 113 117	309.27 308.92 304.66 304.75 301.50 296.28 294.76 290.53 284.98 281.66 279.40 274.39 268.80 262.65 253.26 246.89 235.24 229.21 220.18 210.34 195.90 193.84 182.39 179.02 177.80 170.43	10 14 18 22 26 30 34 34 46 50 58 66 74 78 82 90 94 91 106 110 114 118 122	309.24 309.83 304.48 301.28 295.96 294.01 292.20 289.94 283.78 261.98 272.10 268.12 262.98 272.10 268.37 266.32 262.98 234.44 204.46 203.62 181.54 183.96 180.98 171.54	11 15 19 27 31 339 47 51 59 63 67 77 88 95 90 107 111 119 123	309.11 304.99 304.20 300.93 295.39 293.55 281.70 283.39 280.91 270.91 266.85 264.79 264.79 253.16 247.70 237.54 207.78 207.78 207.78 207.78 209.87 186.60 195.15 175.17 175.38	12 16 20 24 83 32 40 44 48 52 50 64 87 76 90 104 112 1120 124	308.96 304.90 304.14 301.70 301.54 295.03 293.17 291.10 285.02 282.28 280.27 272.66 269.71 272.61 263.09 255.05 251.79 246.91 238.21 319.08 219.38 219.38 219.50 187.80 177.59 176.87 174.01 167.51	ELEMENT TEMPERATURES	

137

162.66

138

164.29

139

140.65

140

161.88

LEMENT Z-STRAINS (5TH INCREMENT)
NOTE: THERMAL AND Z-DIRECTION LOAD DATA SHOWN FOR 1ST AND 5TH INCREMENTS ONLY. COMPLETE SET OF DATA WOULD INCLUDE THERMAL AND Z-DIRECTION LOAD DATA FOR 20 INCREMENTS.

05-17266-2

141 162.75 142 154.66 143 156.47 144 159.01 145 159.69 146 161.13 147 152.08 148 155.46 149 157.14 150 158.58 151 150,22 152 161.24 153 162.26 154 155.59 155 157.47 156 159.48 157 159.70 158 160,41 159 161.58 160 157.03 161 159.07 162 160.67 163 157,77 159.13 164 159.70 165 160,29 166 157.49 167 158.78 168 169 158,28 170 158,95 171 159.65 172 158.73 173 159.24 174 158.91 175 159,15 176 158.86 177 159.04 178 158.93 179 159.05 180 158.99 181 159.00 192 158.99 183 159.00 184 159.00 1 -0.000077 2 -0.000077 3 -0.000077 4 -0.000077 5 -0.000077 6 -0.000077 7 -0.000077 8 -0.000077 9 -0.000077 10 -0.000077 11 -0.000077 12 -0.000077 13 -0.000077 14 -0.000077 15 -0.000078 16 -0.000078 17 -0.000078 18 -0.000078 19 -0.000078 20 -0,000078 21 -0.0000078 22 -0.000079 23 -0.000079 24 -0.000079 25 -0.000079 26 -0.000078 27 -0.000078 28 -0.000078 29 -0.000080 30 -0.000080 21 -0.000080 32 -0,000080 33 -0.000000 34 -0.000080 35 -0.000079 36 -0.000090 37 -0,000080 38 -0.000030 39 -0.000080 40 -0.000080 41 -0.000080 42 -0.000030 43 -0.000081 44 -0.000081 45 -0.000081 46 -0.000082 47 -0.000082 48 -0.000082 49 -0.000082 50 -0.000092 51 -0.000082 52 -0.000083 53 -0.000083 54 -0.000083 55 -0.000083 56 -0.000083 57 -0.000083 58 -0.000083 59 -0.000084 60 -0.000085 61 -0.000085 62 -0.000095 63 -0.000085 64 -0.000084 65 -0.000084 66 -0.000034 67 -0.000085 68 -0.000085 69 -0.000085 70 -0.000085 71 -0.000085 72 -0.000085 73 -0.000035 74 -0.000035 75 -0.000085 76 -0.000085 77 -0.000085 78 -0.000036 79 -0.000086 80 -0.000085 81 -0.000087 82 -0.000087 83 -0.000087 84 -0.000086 85 -0.000087 86 -0.000087 87 -0.000087 99 -0.000089 89 -0.000089 90 ~0.000088 91 -0.000089 92 -0.000089 93 -0.000089 94 -0.000091 95 -0.000091 96 -0.000091 97 -0.000092 98 -0.000092 99 -0,000092 100 -0.000094 101 -0.000094 102 -0.000094 103 -0.000095 104 -0.000095 105 -0.000095 106 -0.000096 107 -0.000096 108 -0.000096 109 -0.000097 110 -0.000097 111 -0.000097 112 -0.000099 113 -0.000099 114 -0.000099 115 -0.000100 116 -0.000100 117 -0.000100 118 ~0.000102 119 -0.000102 120 -0.000102 121 -0.000102 122 ~0.000102 123 -0.000102 124 -0.000104 125 -0,000104 125 ~0.000104 127 -0.000105 128 -0.000105 129 -0.000105 130 -0.000107 131 -0.000107 132 -0.000107 133 -0.000108 134 -0.000108 135 -0.000109 136 -0.000109 137 -0.000109 138 -0.000110 140 -0.000111 139 -0.000111 141 -0.000110 142 -0.000112 143 -0.000112 144 -0.000112 145 -0,000112 146 -0-000112 147 -0.000112 148 -0.000112 149 -0.000112 150 -0.000112 151 -0.000112 152 -0.000112 153 -0.000112 154 -0.000114 155 -0.000114 156 -0.000114 157 -0.000114 158 -0.000113 159 -0.000113 160 -0.000115 161 -0.000115 162 -0.000115 163 -0.000117 164 -0.000117 165 -0.000117 166 -0.000118 167 -0.090118 168 -0.000118 169 -0.000121 170 -0.000121 171 -0.000120 172 -0.000122 173 -0.000122 174 -0.000125 175 -0.000125 176 -0,000126 177 -0.000126 178 - 0.000131 179 -0.000130 190 -0.000133 181 -0.000139 182 -0.000142 183 -0.000148 184 -0.000151

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A.O INPUTB INTERPOLATION AND DATA GENERATION

Purpose - The program INPUTB was developed to serve as an interface between thermal analyzers such as BETA (Boeing Engineering Thermal Analyzer) and BOPACE. For the BETA program the structure is modeled as a network of lumped masses which in general do not correspond to the finite element nodes required for BOPACE. To expedite and automate preparation of thermal input data for BOPACE, INPUTB operates on the output from BETA to produce element temperatures for input to BOPACE. The generation of thermal data for BOPACE is shown schematically in Figure A.O-1. Note that the BETA thermal analyzer can be replaced by any other thermal analyzer (e.g., SINDA, NASTRAN).

However, INPUTB is of a general nature, and it can be used equally well for interpolation and data generation of the user-prescribed element z-direction loads. The INPUTB program will be discussed here in terms of temperature interpolation, but its use in interpolating other quantities should be obvious.

<u>Method</u> - If temperatures are given as functions of time for some two-dimensional mesh of points, then the temperature at any other point and time can be determined by a spatial and temporal interpolation.

The time variations of temperature are computed by a simple linear interpolation, while the spatial variations are treated with an area weighting process equivalent to linear interpolation.

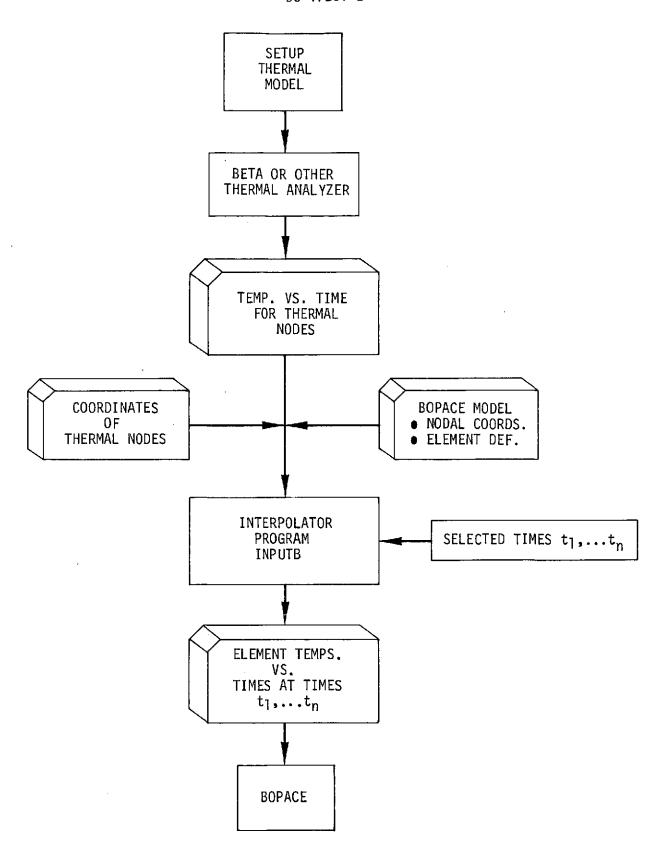


Figure A.O-1: THERMAL ANALYSIS/GENERATION OF THERMAL DATA FOR BOPACE

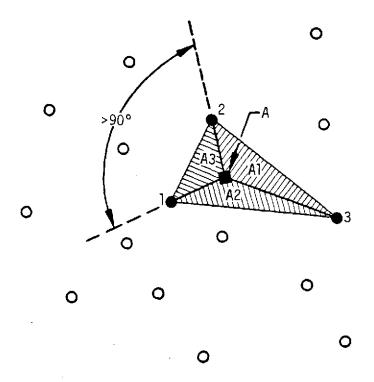


FIGURE A.O-2: SPATIAL INTERPOLATION

DECK SETUP

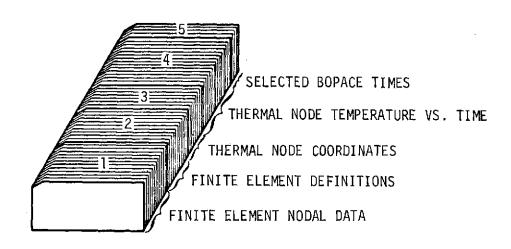


FIGURE A.O-3: INPUTB DECK SETUP

For the spatial interpolation, refer to Figure A.O-2. Assume that the temperature is to be computed at point A. Temperatures at all other points are known. INPUTB logic proceeds as follows.

- (1) Find point 1, the point closest to A.
- (2) Locate point 2 as the next closest point such that the angle between lines A-1 and A-2 is greater than 90°.
- (3) Locate point 3 as the next closest point such that point A is within the triangle 1-2-3.
- (4) The temperature at point A is determined from a weighting of the temperatures at points 1,2,3 according to areas A1, A2, A3, i.e.,

$$T_A = \frac{1}{(A1+A2+A3)}$$
 $(A1*T_1+A2*T_2+A3*T_3)$

(5) Special cases may arise where no triangle can be found according to the above procedure. These special cases have been accounted for.

Summary of INPUTB Data - A pictorial of the INPUTB input deck is shown in Figure A.O-3. The following is a listing of the input data by item (Formats are consistent with FORTRAN IV conventions).

- 1. Finite Element Nodal Data (BOPACE Format)
 - For Each Node: Node I.D.

I.B. of Coordinate System (0-Rectangular,1-Polar)

Nodal Coordinates (X,Y or R,0)

I.D. of Displacement System (O-Rectangular, 1-Polar)

(215,2F10.0,15)

- Blank Card after Last Node
- 2. Finite Element Definitions (BOPACE Format)
 - For Each Element: Element I.D.

Material Number

Thickness

3 Node Numbers (CCW Order)

(215,F10.0,315)

- 3. Thermal Node Coordinates
 - For Each Thermal Node: Node I.D., ICOORD, X(R), Y(θ)
 ICOORD = 0 -Rectangular Coordinates
 ICOORD = 1 -R,θ Coordinates
 Up to 2 Nodes per Card
 2(215,2F10.0)
 - Blank Card After Last Thermal Node
- 4. Thermal Node Temperatures vs. Time
 - Number of Times, Default Temperature (I10,F10.0)

Time (F10.0)

For Each Thermal Node: Node Number, Temperature

Up to 4 Nodes Per Card 4(I10,F10.0)

Blank Card after Last Node

Repeat for each time up to number of times.

For first time, default temperature will be assigned to unspecified nodes. For succeeding times, unspecified nodes will take on value at previous time.

Selected Times

For each time (BOPACE Time) at which Element Temperatures are to be Computed:

• Time, ISTOP (F10.0, I10)

Note: ISTOP = 0, except on card following last time card set ISTOP = 9.

Note: Max Input Times = 20

Max Number of BOPACE Times = 12

Max Number of Thermal Nodes = 300 (Max I.D. = 2000)

Max Finite Element Nodes = 500 (Max I.D. = 2000)

Max Number of Finite Elements = 800 (Max I.D. = 3000)

Output Data - Element Numbers and Temperatures are punched for each of the selected BOPACE times specified in the input as follows.

- Time (F10.4,70(LH*))
- Element Number, Element Temperature 4(I10,F10.2)